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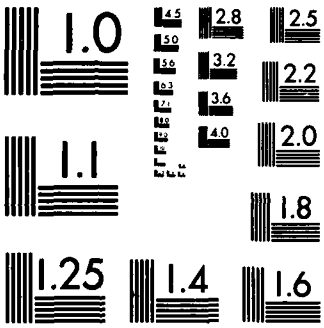
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ECOLOGICAL INVESTIGATION OF A GREENTREE RESERVOIR IN THE DELTA NATIONAL FOREST, MISSISSIPPI

by

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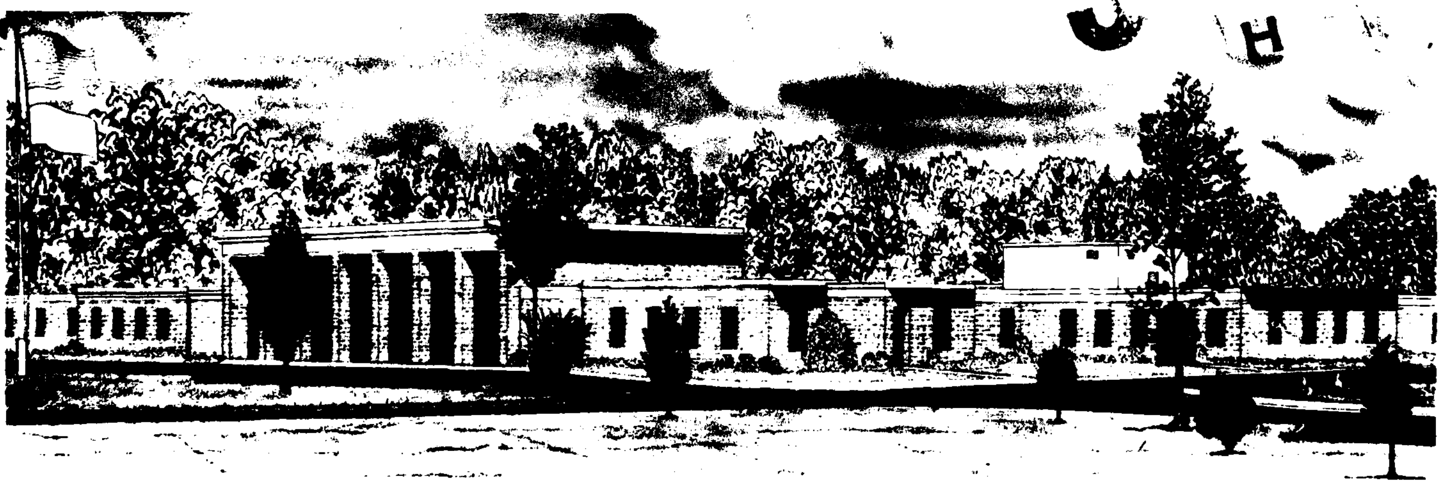
September 1981

Final Report



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A greentree reservoir under continuous dormant season flooding for 18 years was compared with an adjacent reference area to determine the effects of this type of flooding management on the plant community, soils, and bird populations of the area. Continuous greentree management over 18 years appeared to cause a predictable shift to more water-tolerant plant communities in the woody and herbaceous understory strata of the greentree reservoir. Because the design of the greentree reservoir resulted in slower drainage of

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water ponded on the reservoir by rain or backwater flooding during the growing season, neither dormant season flooding, growing season flooding, nor the interaction of both was identified as the sole cause of the community shift. Soils were very similar on both sites. Winter flooding of the greentree reservoir made it more attractive than the reference area to common grackles (*Quiscalus quiscula*) and highly attractive to waterfowl, but less attractive to the white-throated sparrow (*Zonotrichia albicollis*), a ground dweller. For other bird species, however, greentree reservoir management appeared to have very little effect on species richness or mean population sizes.

PREFACE

This report was prepared under the In-House Laboratory Independent Research Program of the U. S. Army Engineer Waterways Experiment Station (WES).

This report was written by Mr. Charles J. Newling, Biologist, Environmental Laboratory (EL), WES, who performed and/or directed all phases of the field work and data analysis with assistance as follows. Most of the bird censusing was conducted by Mr. Michael Buchanan, EL. Plant and soils data were collected with the assistance of Mr. Buchanan, Mr. E. Harris Applewhite, EL, Ms. Jennifer Ficken Buchanan, EL, Mr. C. Stuart Patterson, EL, Mr. William E. Jabour, EL, and Ms. Mary Berndt, EL. Increment coring data were gathered with the aid of Mr. Jabour, Ms. Ramona A. Warren, EL, and Mr. Harvey L. Jones, EL. Consultation in sampling methods and ecological interpretation was provided throughout the study by Mr. Charles V. Klimas, EL. Statistical design and analysis were provided by Mr. David Carlile, Louisiana State University, Department of Experimental Statistics, Baton Rouge. Manuscript review was provided by Dr. Kenneth T. Ridlehuber, Texas A&M University, College Station, Mr. Klimas, EL, Mr. Hollis H. Allen, EL, and Dr. Hanley K. Smith, EL.

Work was performed under the technical leadership and supervision of Mr. Hollis H. Allen, Team Leader, Revegetation and Habitat Development Team, EL; and under the general supervision of Dr. Hanley K. Smith, Ecologist, Wetland and Terrestrial Habitat Group, EL, Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL, and Dr. John Harrison, Chief, EL.

Commanders and Directors of WES during the preparation and publication of this report were COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. Fred Brown.

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ECOLOGICAL INVESTIGATION OF A GREENTREE RESERVOIR IN THE DELTA NATIONAL FOREST, MISSISSIPPI

PART I: INTRODUCTION

Greentree Reservoirs

1. Greentree reservoirs are areas developed in bottomland hardwood forests for the dual purpose of providing wintering habitat for waterfowl and enhancing timber production. They are artificially flooded to a shallow depth during the late fall when trees begin dormancy and are drained in early spring before the trees break dormancy. Food (primarily acorns) and habitat are made available to waterfowl by winter impoundment. When the timing of flooding and draining is managed carefully, it is generally believed that increased soil moisture carried into the growing season increases mast production, improves tree growth, and reduces fire hazards. In theory, a correctly managed greentree reservoir should enhance both waterfowl and timber resources (Rudolph and Hunter 1964). Greentree reservoirs have been used within recent years to mitigate the loss of waterfowl habitat incurred through the construction of flood control projects (U. S. Army Engineer District, Vicksburg 1976).

2. Although greentree reservoirs have been in operation since the late 1930's (Rudolph and Hunter 1964), few studies have been published that quantify the ecological characteristics of these man-made ecosystems. Documentation of waterfowl populations on greentree reservoirs and increases in those populations have have been reported (Hall 1962, Merz and Brakhage 1964, Rudolph and Hunter 1964, Brakhage 1966, Thompson et al. 1968, Cowardin 1969, Sweet 1976). Availability of potential food items was studied by Sweet (1976), Krull (1969), and Hubert and Krull (1973). Hanson (1978) studied incidence of lead shot potentially available to foraging waterfowl at a southern Illinois greentree reservoir. McCracken and Solomon (1980) briefly discussed insect and disease

problems in these reservoirs. Existing information also indicates that failure to drain greentree reservoirs at the prescribed time in the spring may damage or kill trees (Rudolph and Hunter 1964).

3. It has been reported that bottomland hardwood tree species have differential tolerance to flooding. Comprehensive reviews are provided by Gill 1970, Tattar 1972, Teskey and Hinkley 1977, Whitlow and Harris 1979, and Klimas et al. 1981. With respect to greentree reservoirs, short-term studies have reported growth benefits in commercially valuable tree species (Broadfoot 1958, 1964, 1967, 1973; Broadfoot and Williston 1973). However, at least one study (Fredrickson 1979) indicated improved growth may not always occur in greentree reservoirs for all species. Likewise, short-term studies on a particular greentree reservoir in southeast Missouri indicated improved acorn production (Minkler and McDermott 1960, Merz and Brakhage 1964, Minkler and Janes 1965), but a later study covering a longer period on the same site failed to substantiate the earlier findings (McQuilkin and Musbach 1977). Ecological overviews of greentree reservoirs in southern Illinois (Thompson 1971, Thompson and Anderson 1976) and in southeast Missouri (Fredrickson 1979) have illustrated the complexity of these habitats.

4. The purpose of this study was to improve the understanding of the long-term ecological effects of greentree reservoir operation by collecting quantitative data on the overall plant community, soils, hydrology, and nonwaterfowl wildlife component on an area under annual greentree management.

The Study Area

5. The study was conducted on a portion of the 23,941-ha Delta National Forest located in Sharkey County, Mississippi, approximately 45 km north of Vicksburg and 10 km southeast of Rolling Fork (Figure 1). The specific study area (Figure 2) included a 130-ha portion of the 809-ha Sunflower Waterfowl Project and an adjacent 130-ha reference area. The Sunflower Waterfowl Project is a greentree reservoir which has been

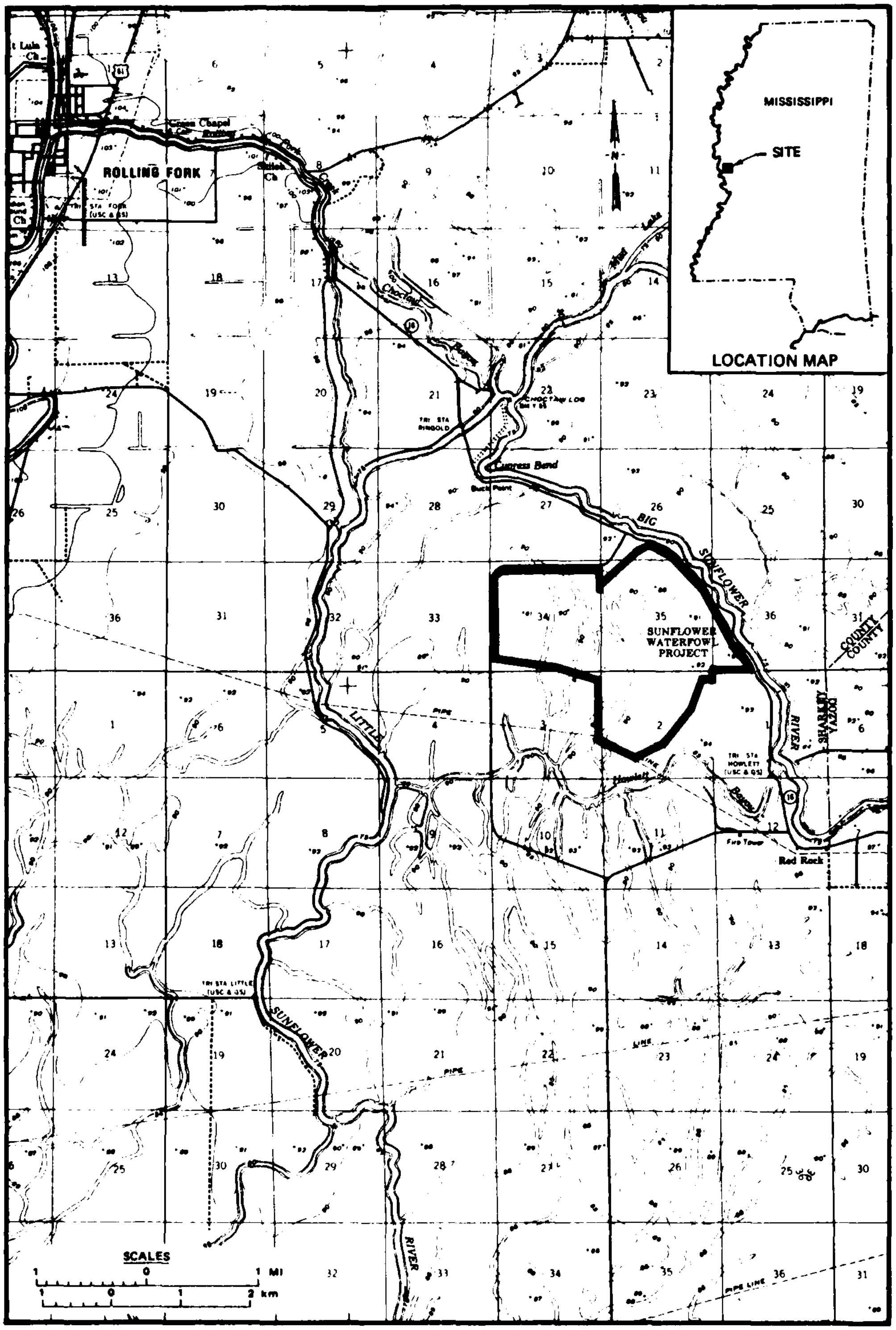

Figure 1. Study area location

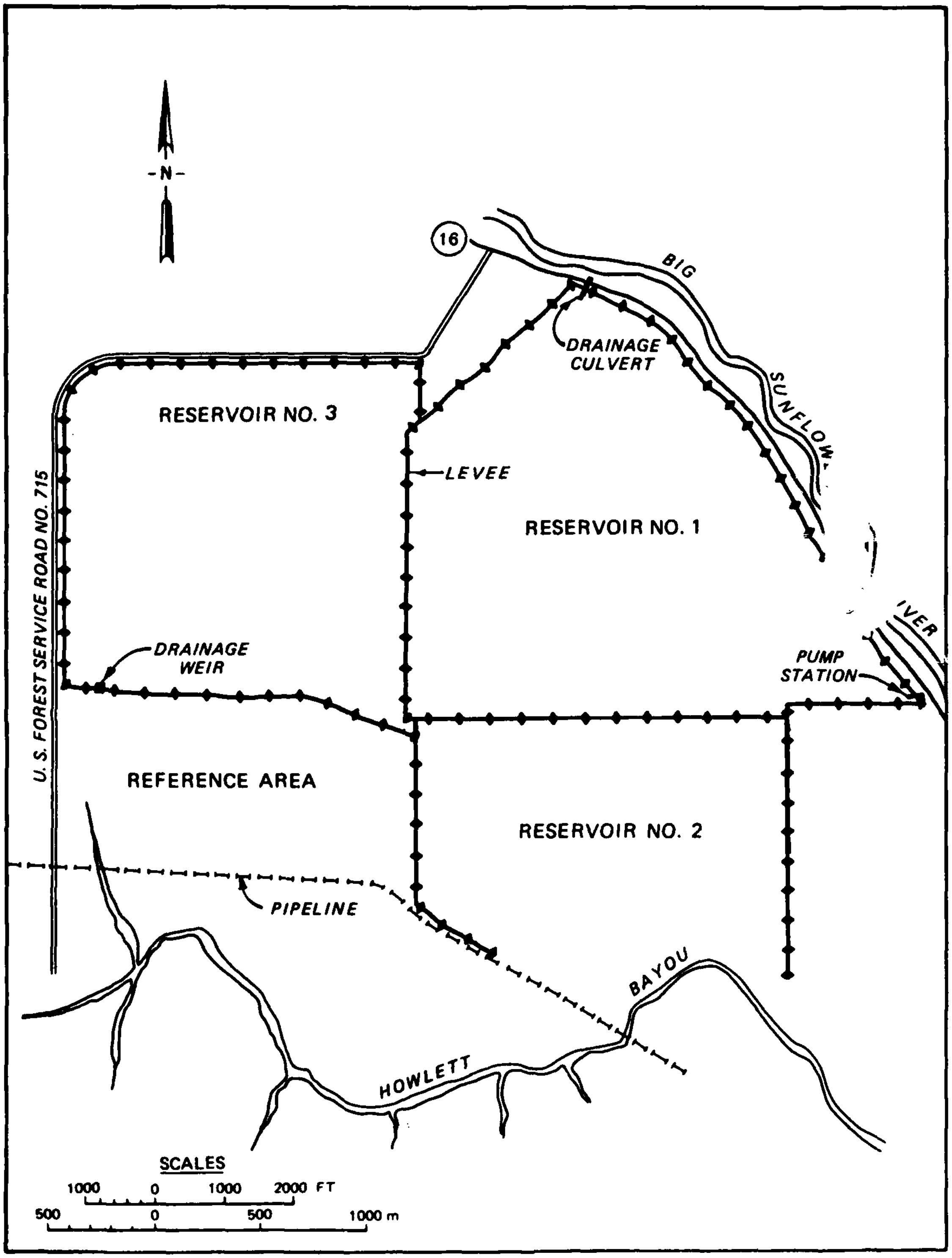

Figure 2. Sunflower Waterfowl Project and adjacent reference area

operated jointly by the Mississippi Department of Conservation and the U. S. Forest Service since 1960.*

6. The study area is located on the expansive alluvial floodplain of the Mississippi River and its tributaries commonly referred to as "the Mississippi Delta" (Carter 1978). It is part of the Mississippi Alluvial Floodplain physiographic region that is located in the northern extension of the Gulf Coastal Plain called the Mississippi Embayment (Carter 1978, Brown 1947).

7. All of the land surface of Sharkey County is of alluvial origin deposited by the Mississippi and Yazoo Rivers (Scott et al. 1962). The greentree reservoir and reference area are composed of flats and depressions formed in slack water areas (Johnson and Price 1959). Flats range from approximately 25.89 m to 27.72 m above mean sea level (msl), while depressions have elevations less than 25.89 m msl (U. S. Army Engineer District, Vicksburg 1964). The soils of the study site are of the Sharkey-Alligator-Dowling association which are level to nearly level with a normal slope of less than 2 percent. Some areas of these poorly drained, fine-textured soils, especially those found along long, narrow depressions, are subject to annual backwater flooding (Scott et al. 1962).

8. Braun (1950) placed the bottomland hardwood forest of the Mississippi River alluvial floodplain in the Southeastern Evergreen Forest Region of the Deciduous Forest Formation although the Delta National Forest completely lacks the evergreen component of this classification (Carter 1978). The climate of the area has been described as temperate with mild, wet winters; hot, humid summers; and fairly constant rainfall throughout the year except in late summer and early fall (Carter 1978). Mean yearly precipitation is 130.53 cm, with the driest month, October, having 6.48 cm and the wettest month, March, 14.45 cm (National Oceanic and Atmospheric Administration (NOAA) 1973). Sleet and snowfall are generally light, and accumulation averages 5.84 cm,

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* Personal communication, John Kerr, 10 April 1981, Division of Wildlife and Fisheries, Mississippi Department of Conservation, Jackson, Mississippi.

most of which occurs in January (NOAA 1975). Mean yearly temperature in the lower Delta is 18°C (NOAA 1973), with an absolute maximum of 41°C and an absolute minimum of -21°C (NOAA 1975). The mean length of the growing season in the area is 225 days (Johnson and Price 1959), with the last spring freeze occurring on approximately 21 March and the first fall freeze approximately 1 November (McWhorter 1962).

9. The lower Yazoo Basin, including the Delta National Forest, is very susceptible to annual spring flooding (Carter 1978). Except during extremely dry years, parts of the Delta National Forest are flooded every year. Water levels of at least 27.41 m for 3 to 4 weeks duration have been recorded at the Big Sunflower River gauging station at nearby Holly Bluff in 55 of the 66 years from 1912 through 1977. During these years, depressions and extensive low-lying flat areas including most of the study area were inundated. During the same 66-year period, water levels of at least 28.02 m (inundating all of the study area) occurred 41 times, and water levels greater than 28.93 m occurred 18 times flooding all but the highest natural levee ridges along the Big Sunflower and Yazoo Rivers. The highest level recorded on the Holly Bluff gauge, 33.66 m, occurred during the 1927 flood (U. S. Army Engineer District, Vicksburg 1981). The highest site in the Delta National Forest is 30.46 m msl (Carter 1978).

10. The Delta region was totally open to annual spring flooding of the Mississippi River and inundation of the entire area was common prior to 1879 when construction of an extensive levee system was authorized (Carter 1978). The entire Delta National Forest was flooded 22 times from 1828 through 1927. Since the completion of an extensive Mississippi River levee system, however, flooding occurs only in high-water years and with less severity. With the exception of the devasting flood of 1927, flooding on the study area has been due primarily to backwater flooding by the Yazoo and Sunflower Rivers (Johnson and Price 1959). Upon completion, the Yazoo Backwater Project, which is presently under construction, will greatly reduce flooding on the Delta National Forest (U. S. Army Engineer District, Vicksburg 1976). This project could have a profound effect on the species composition of the Delta

National Forest, causing a gradual shift to a more xeric forest type (Carter 1978).

PART II: METHODS

Study Site Selection

11. The Sunflower Waterfowl Project was selected as the greentree site (Figure 2) because it was typical of greentree reservoir habitat in the lower Delta and because a very similar reference area could be located nearby. The south half (130 ha) of Reservoir No. 3 within the Sunflower Waterfowl Project was selected as the experimental site. The reference site selected was a 130-ha tract of forest adjacent and immediately south of Reservoir No. 3. Both sites compared favorably on several criteria. Both were composed of SAF forest Type 93 (Society of American Foresters 1975). A brief field survey revealed similar stocking rates on both sites.* The overstory** component of Reservoir No. 3 and the reference area matched well, suggesting the preimpoundment cover types were similar on both sites. The elevations, topography (U. S. Army Engineer District, Vicksburg 1964), and the soils (Scott et al. 1962) of the two sites were very similar. Table 1 presents a comparison of characteristics of the two sites identified prior to data collection.

12. The greentree site has been flooded by pumping from the Big Sunflower River every winter since 1962.† The reference site was flooded naturally by backwater inundation from Howlett Bayou and the Little Sunflower River, with general flooding occurring as previously described for elevations above 27.41 m (Figure 1). With the exception of the winter management season, the greentree site was flooded with the same frequency as the reference area by water which entered through the open weir in the southwest corner of the site. During some years

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* Personal communication, Tom Coppinger, 29 February 1980, USDA Forest Service, Delta National Forest Headquarters, Rolling Fork, Mississippi.

** Complete definitions for technical terms used throughout this report are listed in Appendix B.

† Personal communication, John Kerr, 10 April 1981, Division of Wildlife and Fisheries, Mississippi Department of Conservation, Jackson, Mississippi.

the reference site remained relatively dry, while the greentree reservoir was flooded every winter and emptied rather slowly because its levees and weirs provide only limited rates of drainage. During the growing season, water from a heavy rainfall or backwater flooding ponded on it considerably longer than on the reference site, making the greentree reservoir the wetter of the two sites.

Vegetation and Soil Sampling

13. A randomized block sampling design employing nested circular plots was used to gather vegetation and soil data. Thirty locations comprising five transects with six plots each were sampled on each 130-ha site (Figure 3). Both transects and plot positions were located using a grid system and random numbers (Appendix A).

14. Vegetation sampling was conducted within nested circular plots located relative to a center stake. The overstory or canopy trees (diameter at breast height (dbh) $\geq$6.6 cm) were tallied by species and diameter (to the nearest 0.1 cm) in circular 0.04-ha (11.2-m radius) plots. Dead trees, both standing and fallen, were recorded separately, noting species (if possible), dbh of standing dead, and length and diameter at the middle of all down stems (diameter $\geq$10 cm). Finally, a count was made of all visible tree cavities within the plot which had potential use to wildlife species; the tree species in which the cavity occurred was also recorded.

15. The understory was sampled using nested 0.004-ha (3.6-m radius) circular plots. Living shrubs, vines, and saplings $\geq$1 m in length with dbh less than 6.6 cm were tallied by species. Diameter to the nearest 0.1 cm was recorded for all specimens $\geq$1.0 cm dbh (1.5 m from their rooting point). Height to the nearest 0.5 m was recorded for shrubs and saplings.

16. The herbaceous stratum was sampled using the same 0.004-ha circular plots used to sample the understory. Number of living plants by species was recorded for seedlings (woody plants <1 m in height or length) and herbaceous vascular plants.

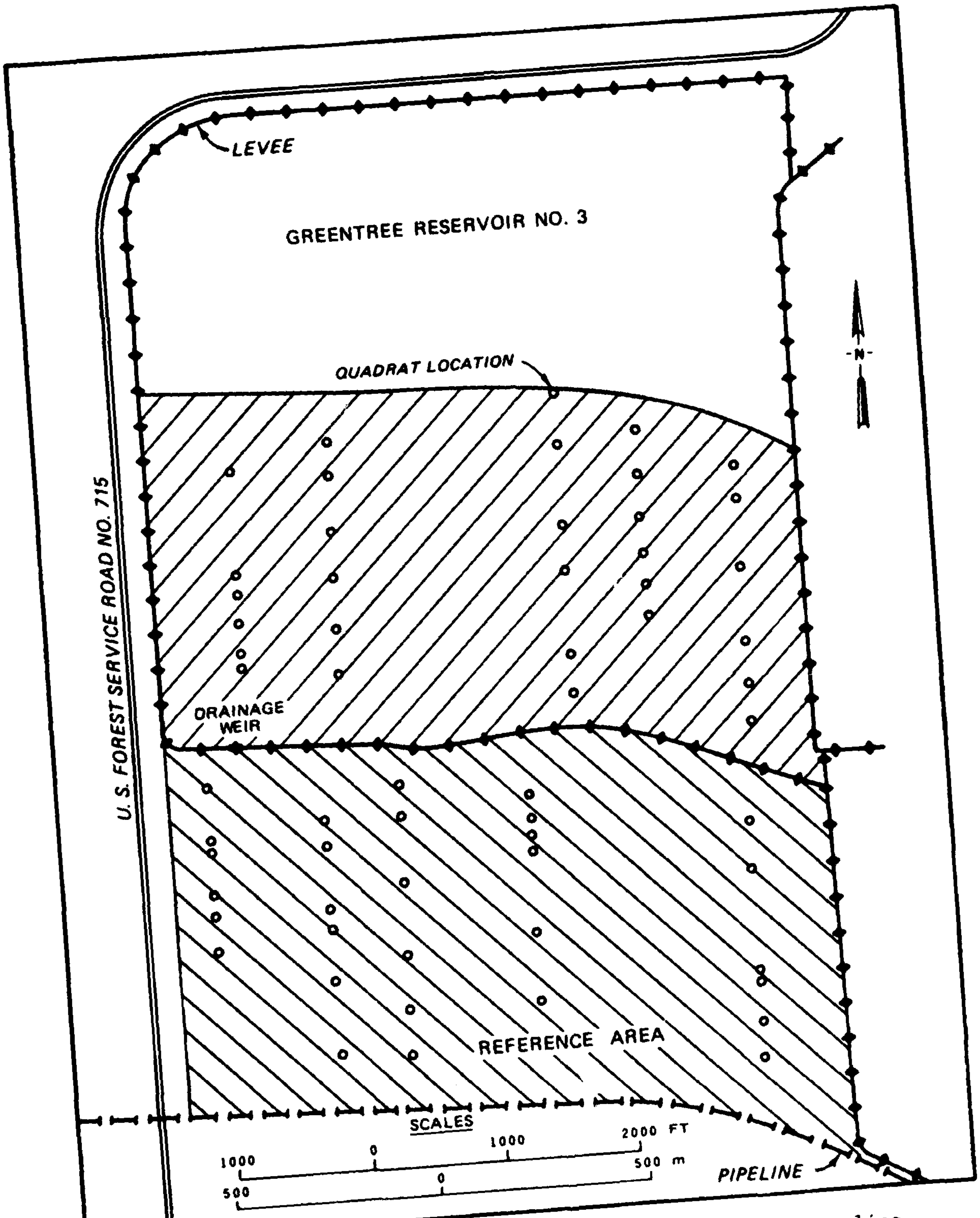

Figure 3. Locations of quadrats for plant and soil sampling

17. Overstory and understory data were summarized by stratum for density, relative density, dominance (basal area), relative dominance, frequency, relative frequency, and importance values (Cox 1967). Herbaceous stratum data were summarized for density, relative density, frequency, relative frequency, and importance values. Data were analyzed using, as appropriate, the parametric t-test (Sokal and Rohlf 1969), or the nonparametric Mann-Whitney U-test (Siegel 1956). The Mann-Whitney U-test was used in those instances where the sample size proved too small to attain a desired level of power and/or because the random variable was measured at an ordinal level. A probability level of 0.10 was used to determine statistical significance. Data analysis and statistical testing were performed using procedures of the Statistical Analysis System (SAS) (Helwig 1978, SAS Institute 1979).

18. In order to detect possible differences between the two sites (reference versus greentree) in mean tree growth rate, increment borings were taken on each site from six unsuppressed trees of each of the following species: water hickory*, sugarberry, green ash, overcup oak, and Nuttall oak. Unsuppressed trees were selected to minimize the growth effects of all environmental factors except inundation. The dbh of each tree was recorded, and then an increment core was obtained using a 41-cm Swedish increment corer. Increment cores were mounted and examined under a dissecting microscope. The width of each ring was recorded for the preceding 36 years (1945 through 1980). This covered the 18-year period of greentree reservoir operation and the preceding 18-year period. The randomization test for independent samples, a nonparametric counterpart of a t-test (Siegel 1956), was used to test for differences in growth between the greentree reservoir and the reference. The random variable used for the test was the difference between a tree's total diameter growth for 18 years prior to flooding and its total diameter growth for 18 years after flooding. The randomization test was used

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* Appendix C lists all scientific and common names of plants used in this report. Scientific nomenclature follows Radford et al. (1968). Where possible common names were taken from Scott and Wasser (1980); otherwise, Radford et al. (1968) or Fernald (1970) were the sources.

because of the interval level of measurement for the random variable and because of the small sample size (n = 6 trees/species/site).

19. A composite soil sample was obtained near the center of each 0.004-ha understory plot. Twelve to eighteen randomly selected 2.5-cm cores were taken to a depth of 15 cm with a split-spoon sampler; combined in a single sample bag; and later subsampled for analysis of grain size, pH, total kjeldahl nitrogen (TKN), total carbon (TC), phosphorus (soluble in dilute acid-fluoride), and exchangable cations (Ca, Mg, K). Test methods for chemical analysis were taken from Black et al. (1965). Analyses were performed by the Geotechnical and Structures Laboratories of the U. S. Army Engineer Waterways Experiment Station.

Bird Census

20. Bird populations in the greentree reservoir and reference site were estimated from counts taken along 0.8-km transects established in each site (Figure 4). To provide comparability with Dickson's (1978) study of a bottomland hardwood forest in south-central Louisiana, similar methods were employed. Multiple-width strips were used to calculate population size; these strips differed in width for each species as did effective detection distances (EDD). An EDD was determined for each species after each count, based on the distribution of detection points perpendicular to the transect center line. It was assumed that all species were detected effectively to a minimum of 12.5 m laterally from the transect center line. Beyond this point, the EDD for each species was the distance beyond which the number of birds per unit area in a strip dropped below 75 percent of the number of birds per unit area for all strips nearer the transect center line (Dickson 1978). Dickson's (1978) EDD corresponds closely with the inflection point that Emlen (1971) used in determining the level of detection for various species. Multiple-width strip distance categories of 6.4, 12.5, 18.9, 25.0, 31.4, 62.8, 125.6, and 251.5 m were selected for easy conversion to area (Emlen 1971, Dickson 1978).

21. A total of 41 counts were made, 3 to 4 each month, from June

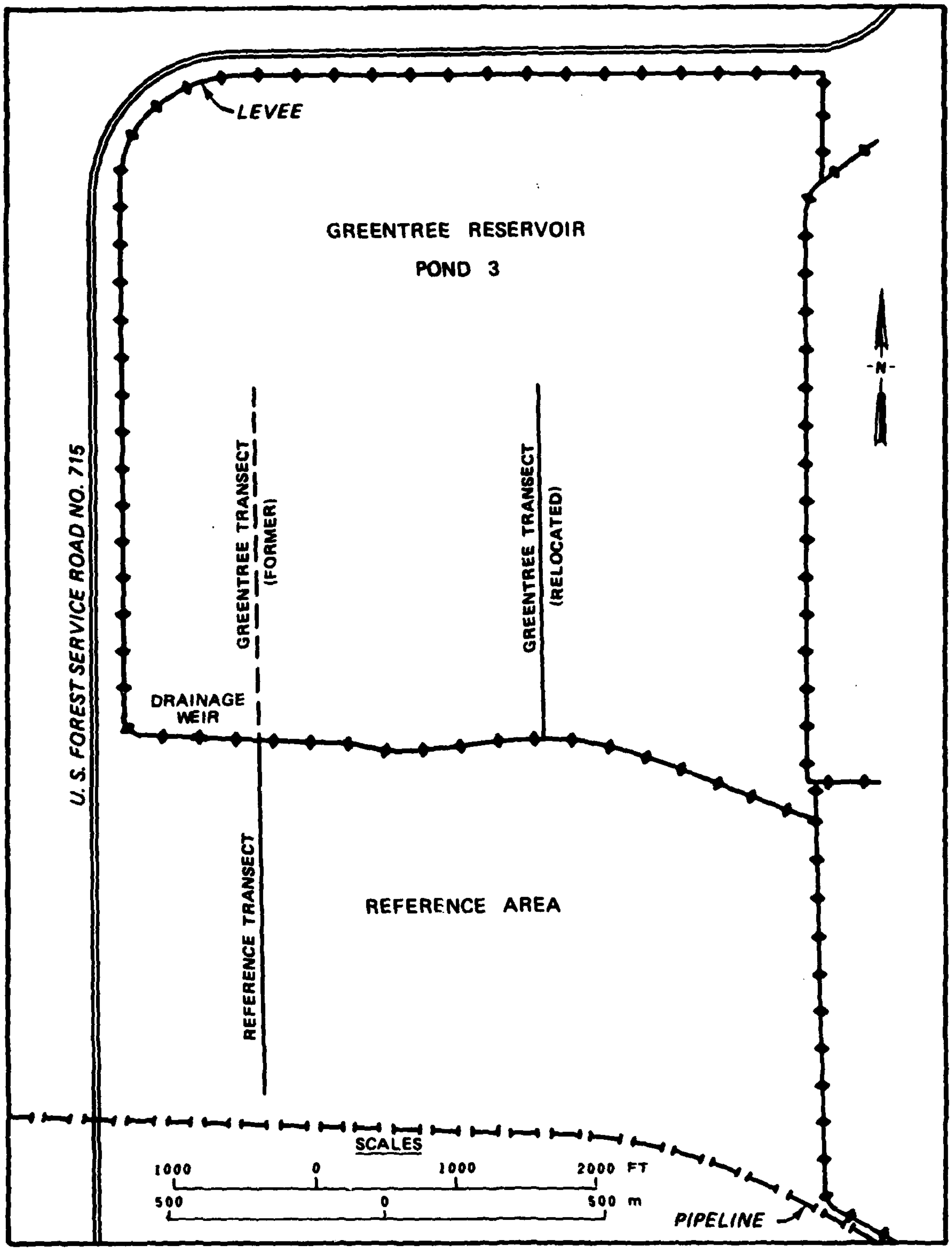

Figure 4. Location of transects for sampling bird populations

1980 to May 1981. The two transects were traversed within 3.5 hr after sunrise, alternating directions on each successive count. Counts were not made during moderate periods of rainfall or high winds (>30 kph). Visual and audial observations were recorded separately; if both types of observation were made for the same species on a given day, the count which yielded the greater calculated population density was reported (Emlen 1971, 1977). Although no distinction was made between male and female birds in recording data, the population figures of permanent and summer residents for this period more accurately represent territorial males (Dickson 1978). This was because from April through July when visual detections were limited by foliage, most of the permanent and summer residents were detected audibly; and as reported by Dickson (1978) the rate of male bird singing is at its highest during this period. Confidence limits cl for mean monthly populations were calculated as $cl = \bar{x} \pm t \sqrt{n^{s}}$ where $\bar{x}$ is the monthly mean, n is the number of counts, s is the standard deviation, and t is the value from a two-tailed t-table in which $1-\alpha$ is the proportion expressing confidence and n-1 is the degree of freedom.

22. Using bird species richness or number of species observed S , bird species diversity H' (Lloyd and Ghelardi 1964) and distribution of bird numbers among species or "equitability" J were determined as in Dickson's (1978) study. Species diversity was calculated as $H' = \Sigma \rho_i \log_e \rho_i$ where ρ_i is the proportion of individuals in the i^{th} species and $i = 1, 2, \ldots S$ (Shannon 1948). Equitability was calculated as $J' = H'/H'_{max}$ where H'_{max} or equal distribution of individuals among a given number of species equals $\log_e S$.

23. After vegetation data and one month of bird data had been collected, a prescribed thinning cut was conducted on portions of the greentree reservoir. Since some of the cuts would occur on part of the original bird observation transect (labelled "former" in Figure 4), the transect was changed to an undisturbed area of similar habitat (labelled "relocated"). Data from June 1981 are from the original transect; the remainder of the data are from the relocated transect.

PART III: RESULTS

Vegetation

24. Vegetation data are summarized by stratum and site. Table 2 presents overstory composition. Based on importance value, sugarberry, Nuttall oak, green ash, and overcup oak ranked first through fourth, respectively, on both areas (see Appendix C for nomenclature). American elm* and water hickory ranked fifth and sixth in importance on the reference area but reversed order on the greentree reservoir.

25. There was no significant difference between the areas with respect to mean number of species per quadrat in the overstory. Included in this group were individuals of vine species and species typically found in the understory, such as common poison ivy, grapes, possumhaw holly, and swamp privet, which met the size class criterion (≥ 6.6 cm dbh). There was also no significant difference between areas for stem density of all overstory species combined; however, there were exceptions among individual species. Stem densities of overstory water hickory and green ash were significantly greater on the greentree reservoir ($p < 0.0386$ and $p < 0.0711$, respectively). Overstory common poison ivy had a significantly lower stem density ($p < 0.0804$) on the greentree reservoir. Basal areas of green ash and overcup oak were significantly lower on the greentree reservoir ($p < 0.0320$ and $p < 0.0675$, respectively).

26. Table 3 presents tree occurrence by diameter class in 5.1-cm increments. A relatively even distribution of diameter classes greater than 21.9 cm was observed. These data imply similarity of past treatment on the two sites.

27. Increment cores were analyzed for sugarberry, green ash, overcup oak, and Nuttall oak. Because of difficulty in determining ring

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* Both American elm (*Ulmus americana*) and slippery elm (*U. rubra*) occurred in the study area, with American elm the more abundant species. No distinction was made between these two species; the label "American elm" includes data for both.

boundaries, water hickory increment cores were not analyzed. Table 4 lists the mean diameter growth for the 18 years prior to greentree reservoir management (1945 through 1962), for the 18 years since management has been implemented (1963 through 1980), and for the 36 years combined.

28. Figure 5 illustrates the differences in total diameter growth of the sampled trees before and after flooding management on the two areas. There was no statistical difference in total diameter growth for sugarberry or Nuttall oak. Rates of growth over the two periods of time were almost identical for sugarberry on both sites. Nuttall oak decreased growth substantially on both sites; however, the difference in total growth between the two areas was not significantly different. The difference in total growth between the two areas was significant for green ash ($p < 0.0465$) and overcup oak ($p < 0.0855$). Total diameter growth for reference area green ash increased slightly during the most recent 18 years, while it slowed substantially on the greentree reservoir. Total diameter growth for overcup oak slowed for both sites over the most recent 18 years, but to a lesser degree on the greentree reservoir.

29. Data for dead trees, both standing and down, are summarized in Tables 5 and 6, respectively. When calculated with data for living trees, standing dead of all species combined rank fifth in importance value (24.89) on the reference site and fourth in importance (37.06) on the greentree reservoir. Many of the standing dead trees were unidentifiable, and this group accounted for the greatest importance value among standing dead trees on both sites. Standing dead of overcup oak and sugarberry were second and third in importance for standing dead trees on the reference site. Sugarberry was second and water hickory third in importance for standing dead trees on the greentree reservoir. There was no significant difference between total numbers of standing dead trees on the two sites. There was a somewhat greater density of down dead stems on the greentree reservoir but a greater mean volume on the reference site.

30. Data on densities and relative densities of cavity trees and number of cavities per hectare are summarized in Table 7. The density

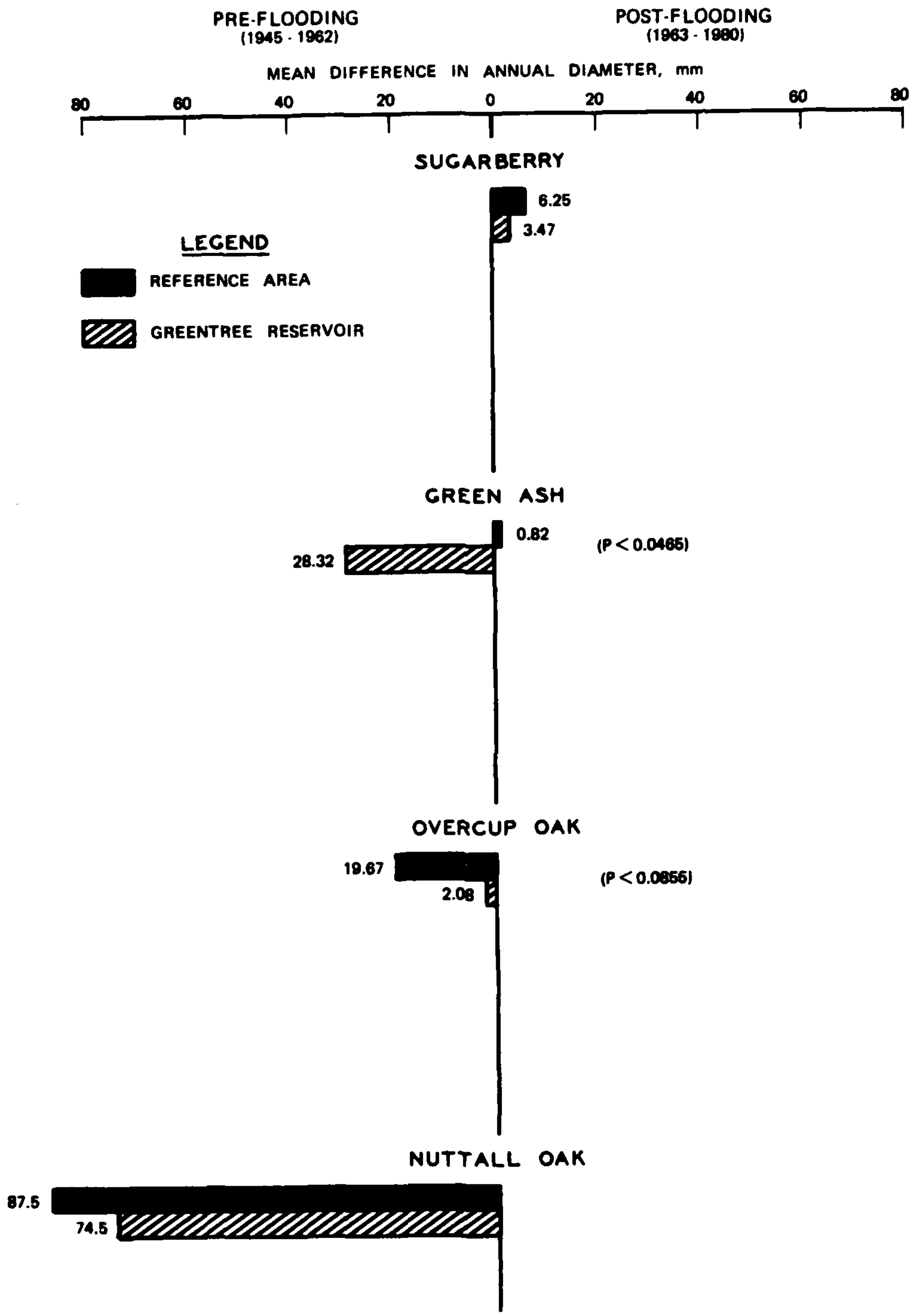

Figure 5. Difference in total annual diameter growth before and after initiation of greentree reservoir management for four tree species

of cavity trees was slightly greater on the reference site, but the total number of cavities per hectare was somewhat greater on the greentree reservoir. On both sites, sugarberry was the most important cavity-bearing species, with green ash a distant second.

31. Table 8 summarizes understory data for shrubs, vines, and saplings. Based on importance value, there was a substantial difference in the composition and relative importance of the five most important understory plants on the two sites. On the reference site, possumhaw holly, sugarberry, grapes, common poison ivy, and Carolina snailseed ranked first through fifth, respectively, in importance value. On the greentree reservoir, water hickory, swamp privet, overcup oak, sugarberry, and possumhaw holly ranked first through fifth, respectively. Figure 6 is a graphic comparison of the importance values for understory species illustrating differences between the two sites.

32. Stem densities of understory species were significantly greater ($p < 0.0013$) on the greentree reservoir (638 stems/ha) than on the reference site (448 stems/ha). Fewer species (25) were sampled on the greentree reservoir than on the reference site (28), but the difference was not significant. The following species had significantly higher stem densities on the greentree reservoir: water hickory ($p < 0.0003$), overcup oak ($p < 0.0208$), Alabama supplejack ($p < 0.0822$), and common buttonbush ($p < 0.0490$). On the reference site the following species had significantly higher stem densities: Carolina snailseed ($p < 0.0002$), vine starjessamine ($p < 0.0139$), trumpet creeper ($p < 0.0170$), and saw greenbriar ($p < 0.0472$).

33. The mean height of shrubs and saplings was lower on the greentree reservoir (3.3 m) than on the reference site (3.6 m), but the difference was not significant. There was no statistical difference for mean height by species on the two sites except for sugarberry, which had a lower mean height ($p < 0.0618$) on the greentree reservoir (3.2 m) as compared with the reference site (4.2 m).

34. The dbh's of shrubs, vines, and saplings were smaller on the greentree reservoir (2.5 cm) than on the reference site (2.9 cm), but the difference was not significant. The diameter of pepper-vine was

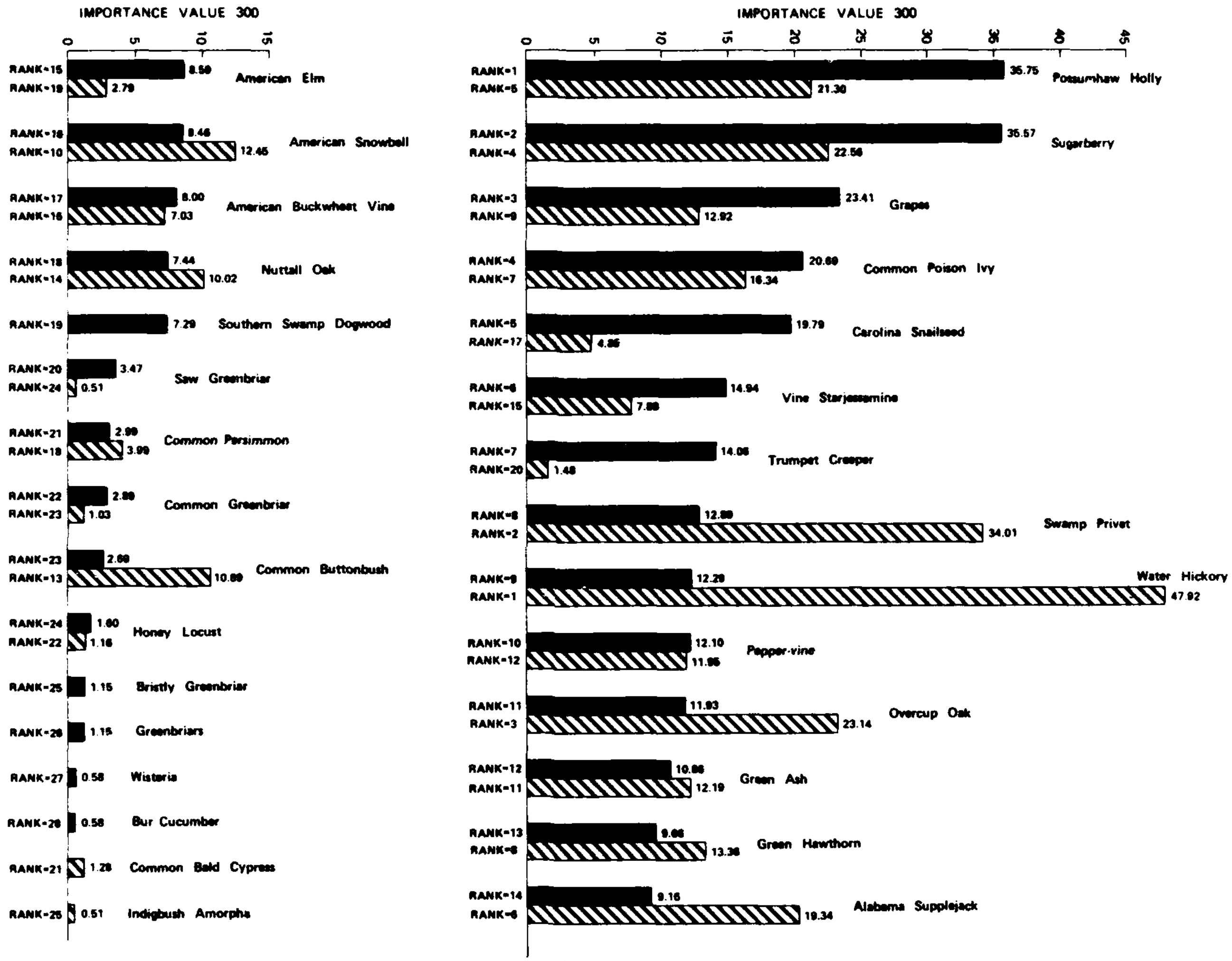

Figure 6. Importance value 300 for understory species on the reference site (solid) and greentree reservoir (striped) by decreasing rank on the reference area

significantly greater ($p < 0.0476$) on the greentree reservoir. The diameter of sugarberry was significantly less ($p < 0.0049$) on the greentree reservoir. Differences between sites for other species were not significant.

35. Herbaceous layer data are summarized in Table 9. Seedlings of woody species were the primary component of the herbaceous layer. Based on importance value, there were substantial differences in composition and species rank between the two sites. In descending order, the ten most important herbaceous layer species on the reference site were vine starjessamine, common poison ivy, sugarberry, Carolina snailseed, American buckwheat vine, pepper-vine, trumpet creeper, saw greenbriar, swamp privet, and American snowbell. In descending order, the ten most important herbaceous layer species on the greentree reservoir were common poison ivy, vine starjessamine, pepper-vine, American buckwheat vine, swamp privet, sugarberry, water hickory, overcup oak, Carolina snailseed, and American snowbell. Figure 7 is a graphic comparison of the importance values for herbaceous layer species.

36. Stem density for herbaceous layer species was significantly less ($p < 0.0001$) on the greentree reservoir (30,568 stems/ha) than on the reference site (68,808 stems/ha). A significantly lower number of herbaceous layer species ($p < 0.0001$) was sampled on the greentree reservoir (27) than on the reference area (52). It should be noted that 19 of the species that did not occur in greentree reservoir sample plots were found in only one sample plot on the reference area. Based on t-test results, the following species had significantly lower stem densities on the greentree reservoir: vine starjessamine ($p < 0.0008$), sugarberry ($p < 0.0001$), Carolina snailseed ($p < 0.0001$), American buckwheat vine ($p < 0.0249$), trumpet creeper ($p < 0.0001$), saw greenbriar ($p < 0.0001$), and green hawthorn ($p < 0.0118$). Using the Mann-Whitney U-test the following additional species also had significantly lower stem density on the greentree reservoir: common poison ivy ($p < 0.0624$), smallspike false nettle ($p < 0.0056$), and Nuttall oak ($p < 0.0176$). On the greentree reservoir, only Alabama supplejack ($p < 0.0254$; t-test) and water hickory ($p < 0.0374$;

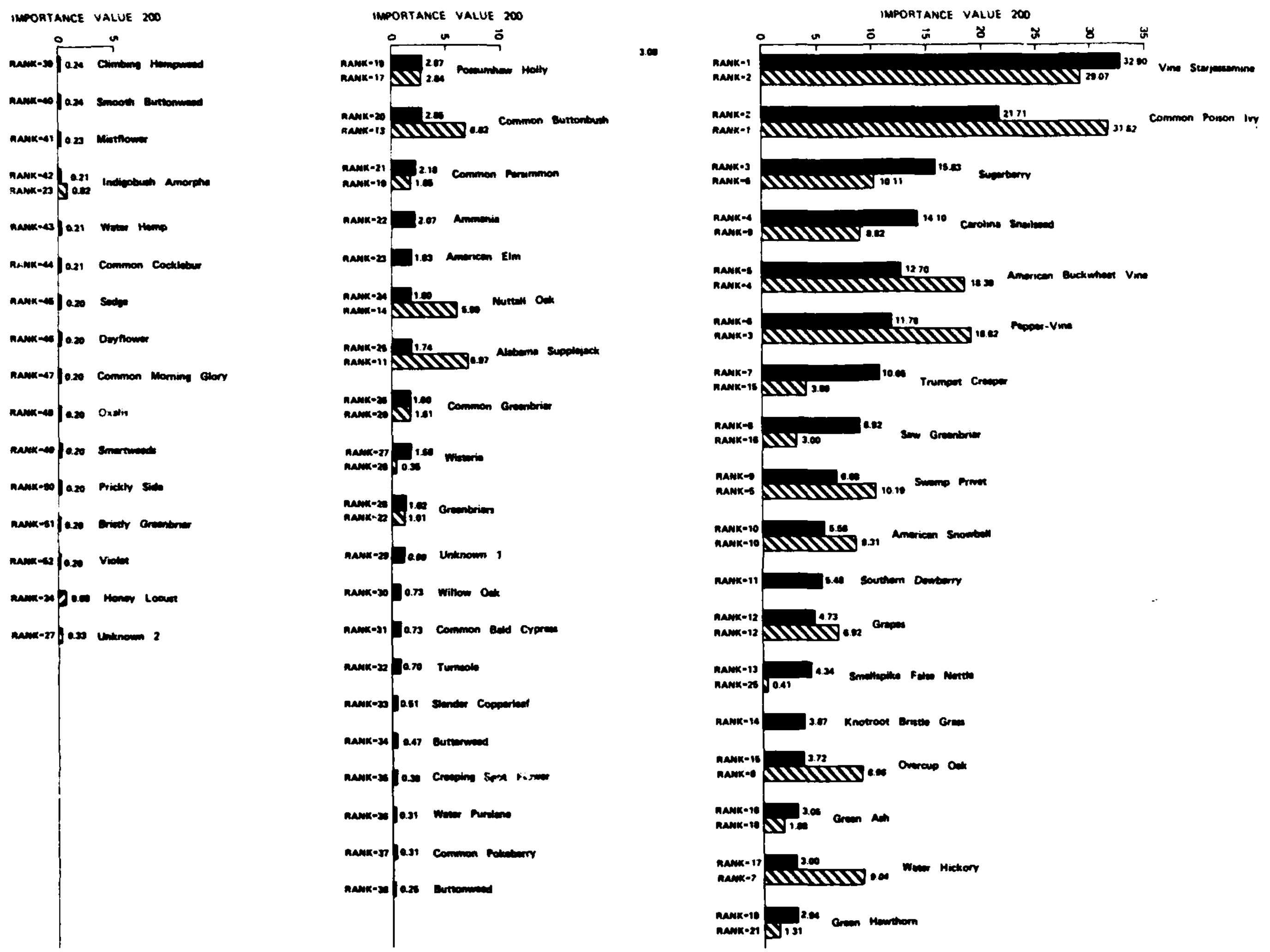

Figure 7. Importance value 200 for herbaceous layer species on the reference site (solid) and the greentree reservoir (striped) by descending rank on the reference site

Mann-Whitney U-test) had significantly greater stem density.

Soils

37. A comparison of mean values calculated from data on physical and chemical analyses of soils is presented in Table 10. Although slight differences occurred in the physical character of the soil, mean values for the other parameters measured were very similar for both sites. These results indicate normal variability for Sharkey soils which usually exhibit a high degree of similarity among nearby sites.* Soil characteristics were sufficiently uniform that no further discussion will be presented in this report.

Bird Populations

38. Bird census results closely paralleled the findings of Dickson (1978). Effective detection distances ranged from 12.5 m for the less conspicuous species to 251.5 m for those more easily seen or heard. Species detected within the shortest distances were primarily weak-voiced or nonvocal. Censusing results were more consistent with the conspicuous birds. Individual transect counts fluctuated the least on both sites during the spring and summer breeding season when confidence limits reached seasonal lows (Figures 8 and 9). These results agreed closely with the findings of Dickson (1978) that more uniform detectability of singing male birds and reduced mobility apparently produced lower variances in counts. Trends were similar on both sites, but winter peaks were magnified on the greentree reservoir. High monthly variances during the winter were due primarily to wandering bird flocks.

39. Nonvocal birds, difficult to census when trees were in leaf, included migrants and juveniles, particularly in those species which were sedentary or frequented high canopy habitat. The pattern described

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* Personal communication, B. R. Wells, 19 June 1981, University of Arkansas, Rice Experiment Station, Stuttgart, Arkansas.

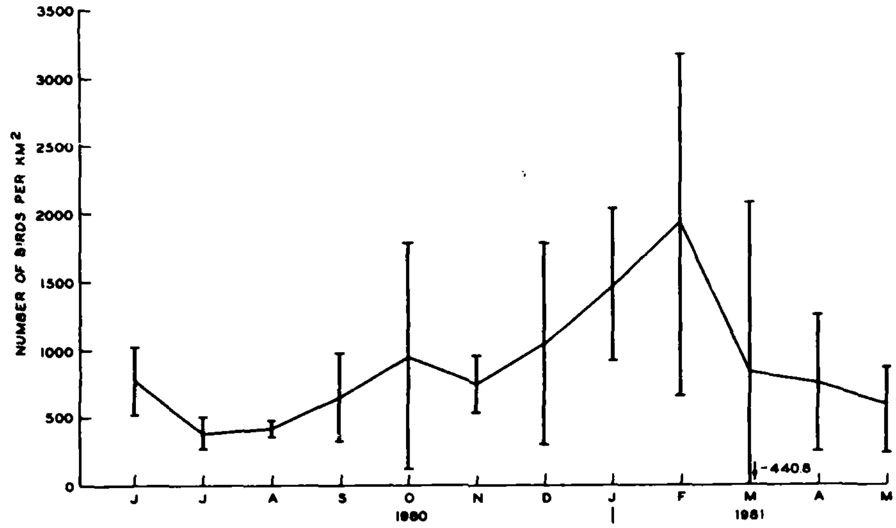

Figure 8. Means and 95 percent confidence limits of monthly bird populations determined from transect counts on the reference site (One-half of the March and all of the April through July figures represent territorial males.)

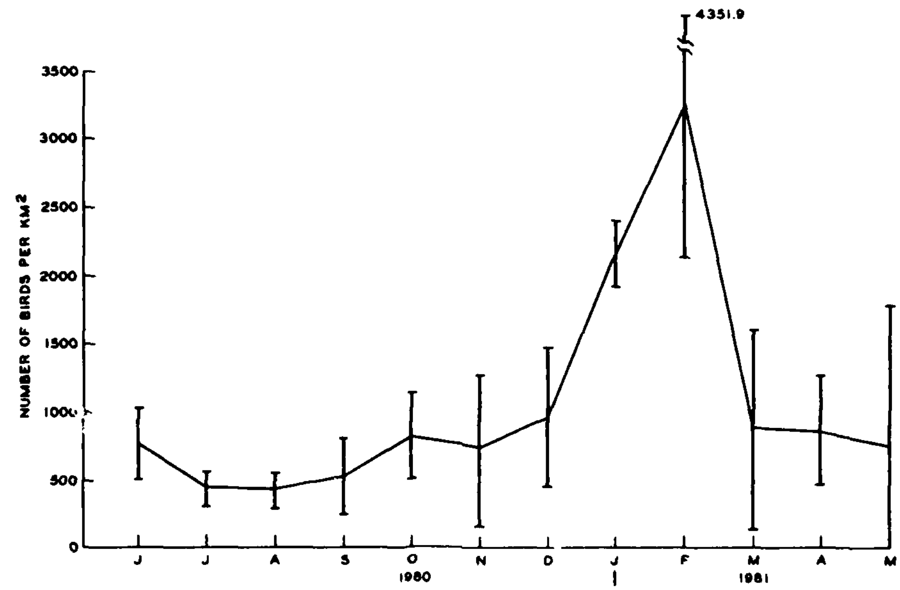

Figure 9. Means and 95 percent confidence limits of monthly bird populations determined from transect counts on the greentree reservoir (One-half of the March and all of the April through July figures represent territorial males.)

by Dickson (1978) was observed for most species of breeding birds. Higher numbers were censused during the peak calling period in spring, rather than in the summer when birds were seasonally abundant but less vocal.

40. Both the reference area and the greentree reservoir provided suitable habitat for large numbers of both permanent residents and wintering species that breed at more northerly latitudes. Winter bird population means on the reference area ranged from 1041 to 1972 per km^2. On the greentree reservoir they ranged from 966 to 3244 per km^2. The winter populations on both sites were the highest for any season. These winter densities were comparable to but somewhat higher than those found by Dickson (1978) in a south-central Louisiana bottomland hardwood forest where bird densities ranged from 1235 to 2035 per km^2. The winter bird community was dominated on both sites by the common grackle. Wood ducks and mallards were the second largest component of the winter community of the (flooded) greentree reservoir but were absent on the reference site. Likewise, white-throated sparrows added substantially to the winter population of the reference site but were virtually absent on the greentree reservoir. American robins and yellow-rumped warblers contributed to the enlarged winter populations of both sites. The residency statuses of bird populations on the reference site and greentree reservoir are illustrated in Figures 10 and 11, respectively. The residency statuses of the bird species on the reference site and greentree reservoir are illustrated in Figures 12 and 13, respectively.

41. No peaks were noticed on either site during spring, although populations remained relatively high due to the lingering of winter residents and the influx of summer residents. Low bird numbers were recorded during July and August on both the reference area (392 and 422 per km^2) and on the greentree reservoir (443 and 430 per km^2). Both sites showed a slight peak during October (Figures 8 and 9), which appeared to be the result of influxes of American robins, yellow-rumped warblers, and common grackles.

42. With the exception of enhanced peaks on the flooded greentree reservoir during the winter, total bird populations on both sites were

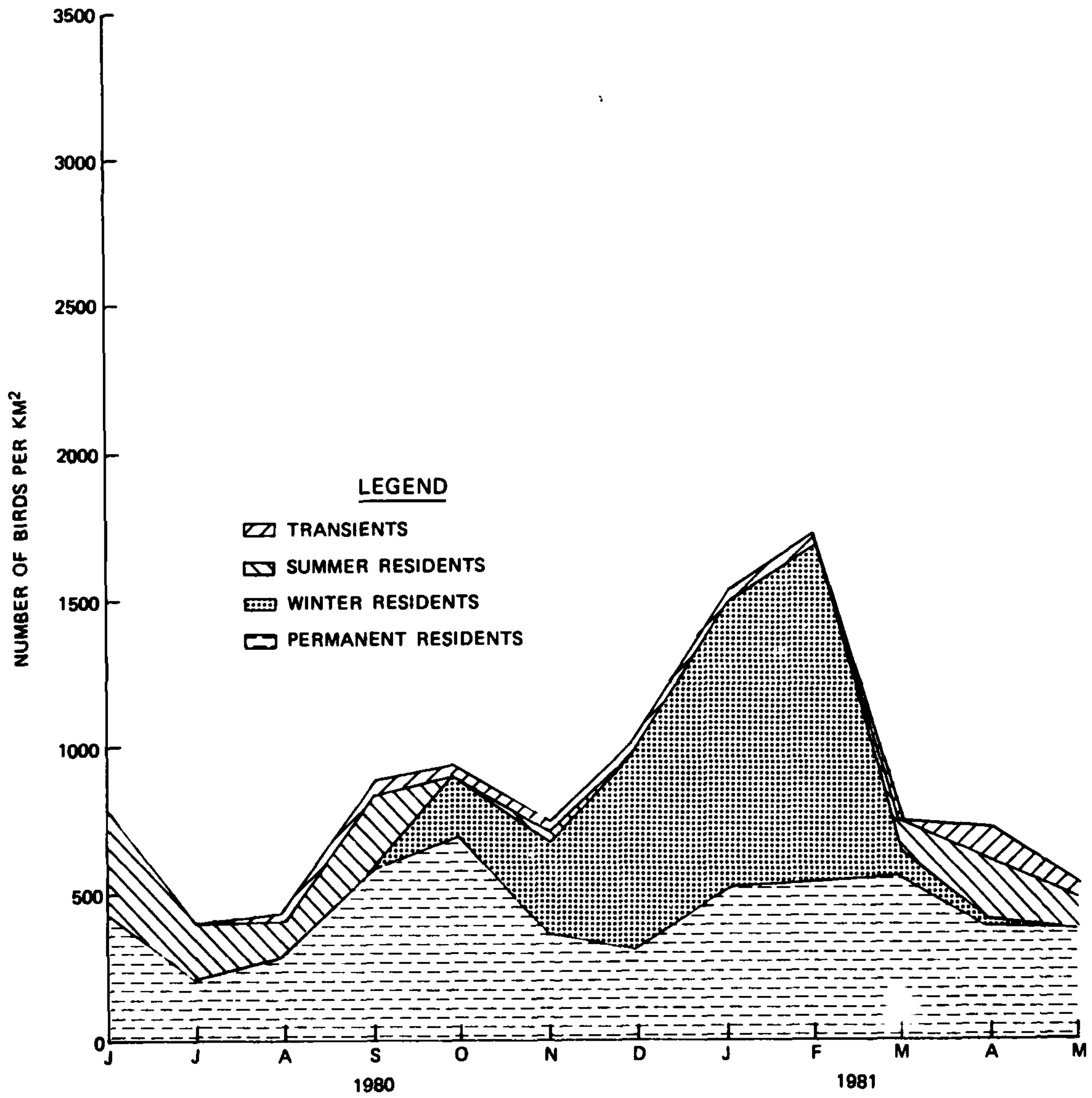

Figure 10. Residency status of reference site bird populations

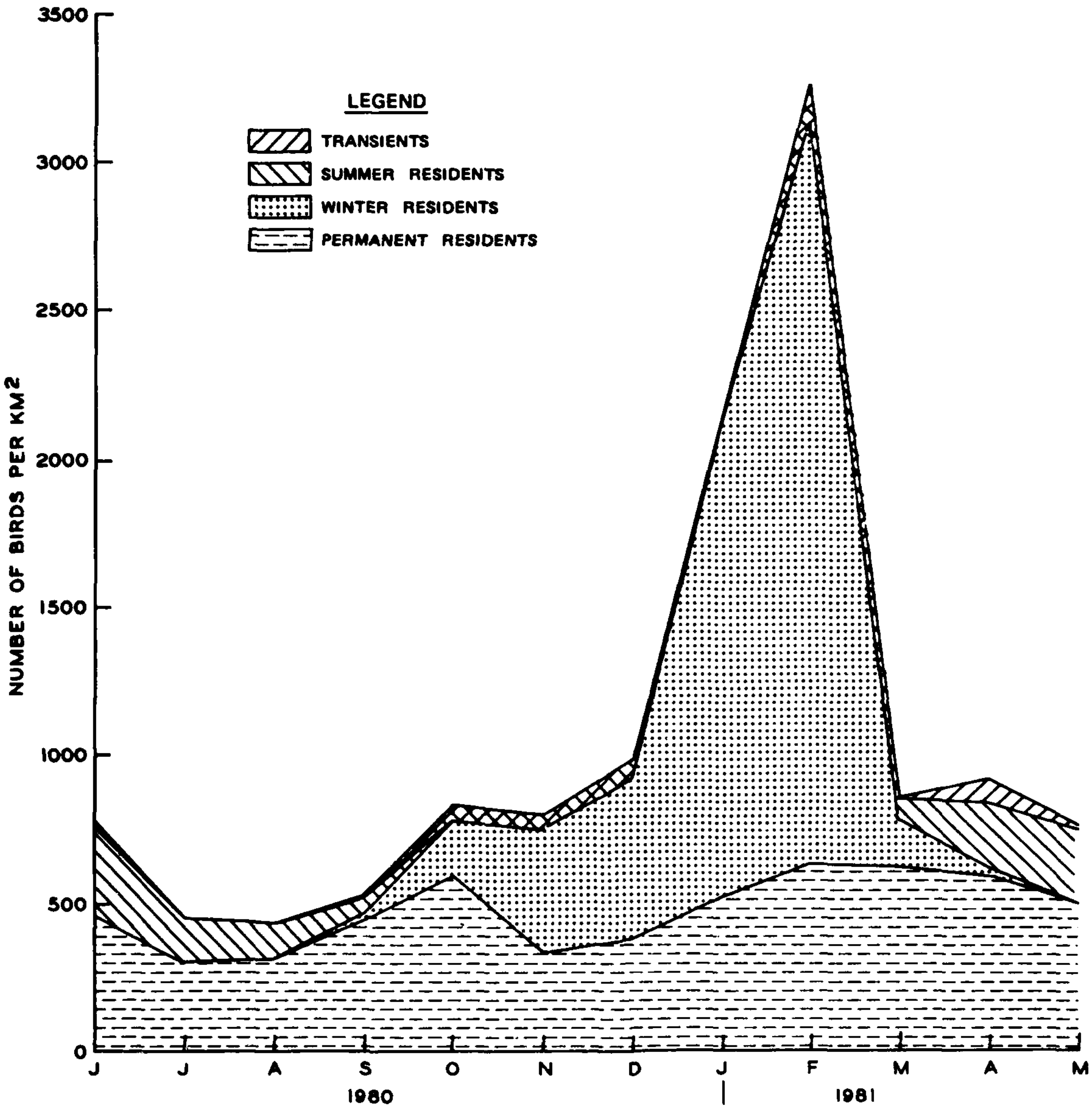

Figure 11. Residency status of greentree reservoir bird populations

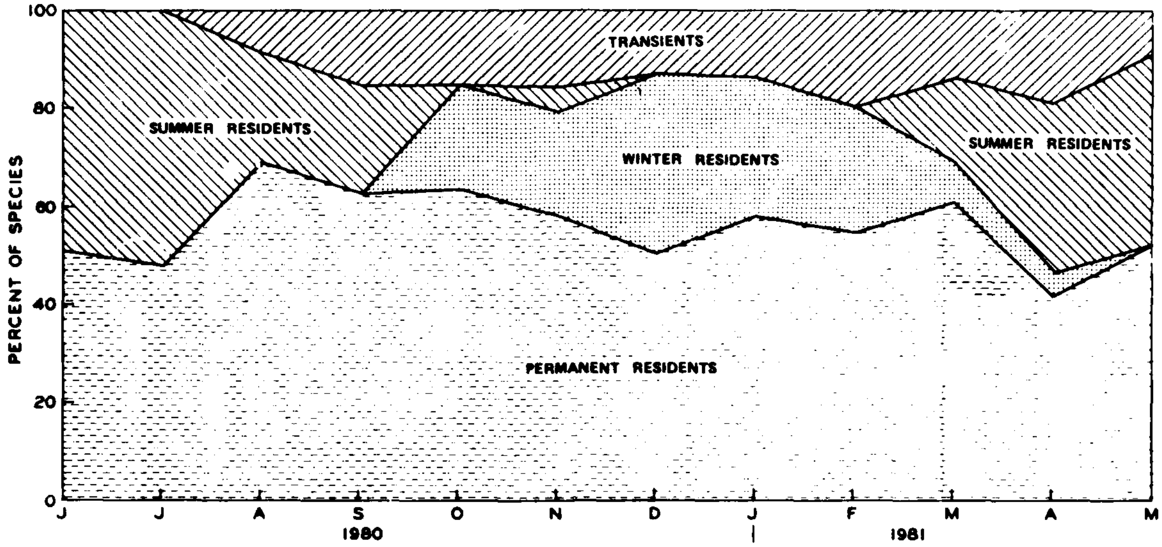

Figure 12. Residency status of reference site bird species

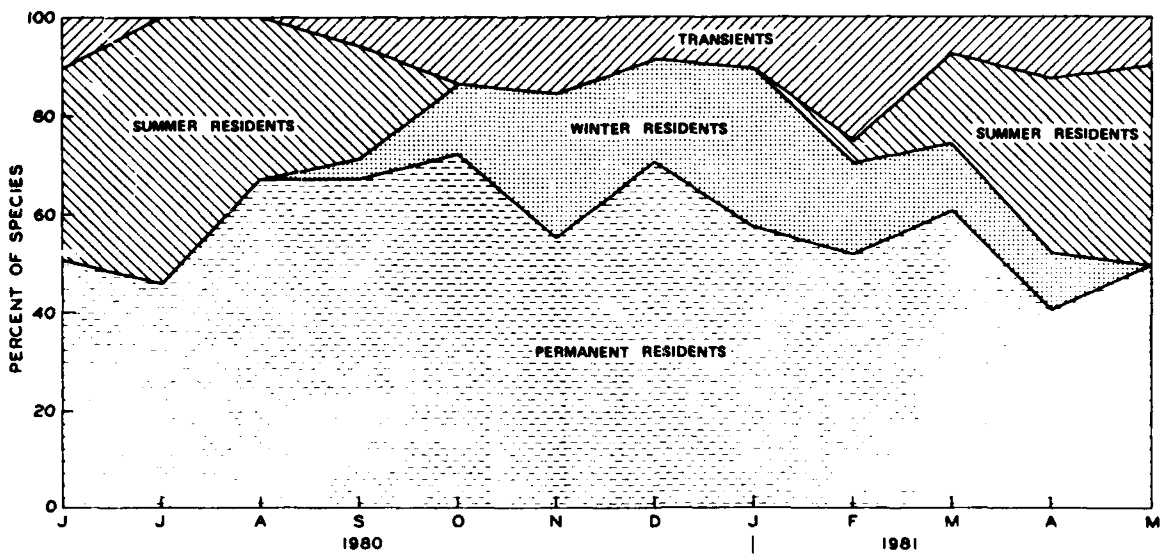

Figure 13. Residency status of greentree reservoir bird species

highly consistent throughout the year. Mean monthly population estimates are summarized by species in Table 11.

43. A total of 48 species of birds representing 19 families were identified and censused on the two sites. On the reference site, 43 species of 17 families were censused. Red-tailed hawk, yellow-bellied sapsucker, golden-crowned kinglet, black and white warbler, rufous-sided towhee, and song sparrow were censused only from the reference site. On the greentree reservoir, 39 species of 19 families were censused. Wood duck and mallard were censused only from the greentree reservoir.

44. Species richness (i.e., number of species), species diversity, and species equitability are illustrated for the reference site and the greentree reservoir in Figures 14 and 15, respectively. Patterns similar to those documented by Dickson (1978) were observed. There was little relationship between species richness and species diversity for either site. Species diversities for both sites were more closely associated with species equitability.

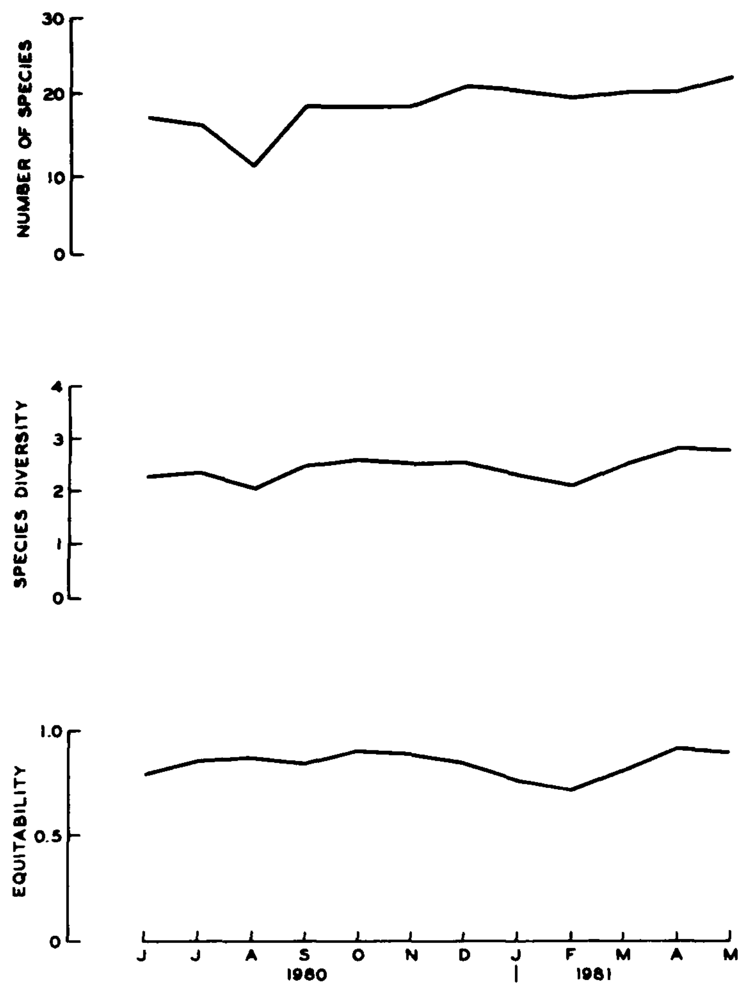

Figure 14. Monthly number of bird species, species diversity, and equitability for the reference site

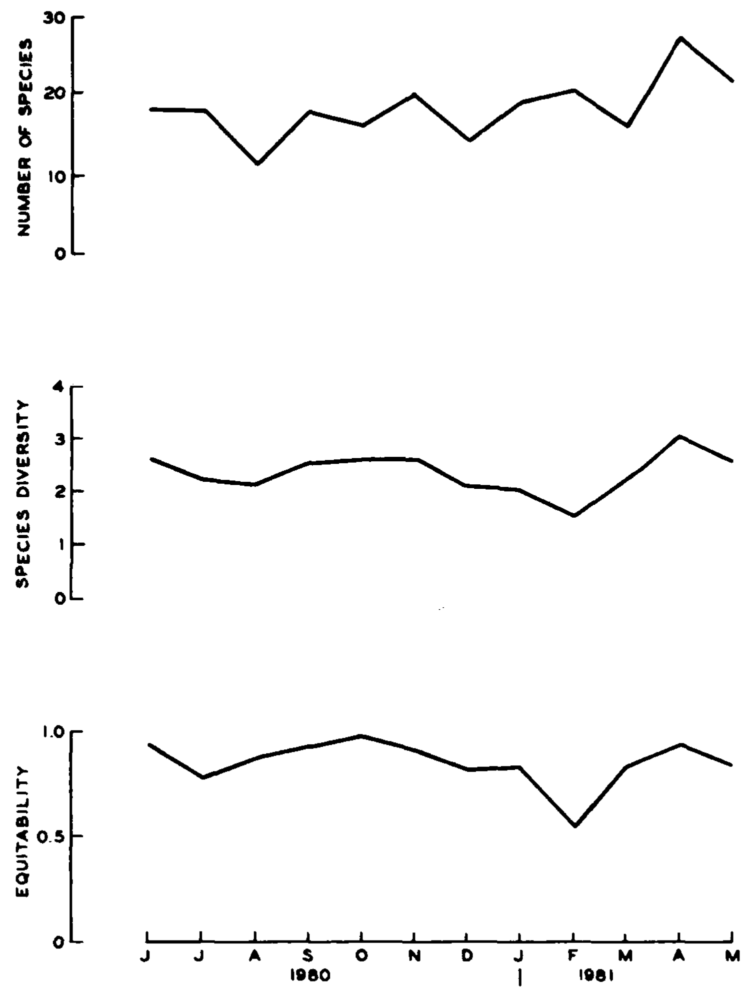

Figure 15. Monthly number of bird species, species diversity, and equitability for the greentree reservoir

PART IV: DISCUSSION

45. The strong agreement in overstory data between the two sites supports the premise that there was probably no difference in vegetation between them prior to the initiation of greentree reservoir management. The lower basal area of green ash and overcup oak in the greentree reservoir may be due to differences in past selective harvesting practices. It is unlikely that any timber harvest has taken place on the greentree reservoir since its construction; however, no written records exist which can verify past cutting practices.* Thus care must be exercised in interpreting these results. The increased stem density of water hickory and green ash occurred in the smallest size classes (Table 3) which have developed since initiation of the greentree reservoir, indicating increased germination and/or survival of these species under the greentree management.

46. As noted in the preceding section, there was no evidence that greentree reservoir management enhanced or reduced growth rate for sugarberry and Nuttall oak. However, the evidence indicated that on the greentree reservoir there was both a slower rate of growth for green ash and a reduced rate of growth decline for overcup oak. This contrasts with early studies of greentree reservoirs and other dormant season impoundments that frequently reported improved tree growth (Broadfoot 1958, 1967, Broadfoot and Williston 1973) and better production of sound, fully developed acorns (Minckler and McDermott 1960) which may be an indication of tree vigor. It agrees with more recent studies which indicate that long-term response may not be so universally improved as was earlier thought. Studying a 20-year-old greentree reservoir in southeastern Missouri, Fredrickson (1979) found that tree growth improved for pin (*Quercus palustris*), willow, and overcup oaks, but was reduced for red maple, Shumark oak (*Q. shumardii*), and sweetgum. Rogers (1981) reported that pin oak growth had not improved and may have been somewhat reduced after 20 years of dormant season impoundment. McQuilkin

* Personal communication, Tom Coppinger, 29 February 1980, USDA Forest Service, Delta National Forest Headquarters, Rolling Fork, Mississippi.

and Musbach (1977) found no increase in sound, fully developed acorns produced on a greentree reservoir after 14 years of data had been collected. This is in contrast with increased production reported for the same site after a shorter period of study (4 years) by Minckler and McDermott (1960). This discussion illustrates that increases in growth and vigor frequently reported in the period immediately following flooding changes may, in some cases, be short-lived and do not preclude eventual water-induced decline or mortality. Beneficial growth effects may have been overstated in the past; they probably do occur, but are more species and site specific than was previously thought (Klimas et al. 1981).

47. Most of the large green ash specimens encountered on the study area showed signs of heart rot and other evidence of disease, which may be the mechanism by which growth rate is slowed. No obvious conditions were observed that might relate to the difference in decline of growth rate between the sites for overcup oak. However, the reduced rate of growth decline coupled with increased reproduction, as evidenced by increased stem density in the understory and herbaceous layer of the greentree reservoir, suggests that greentree reservoir management is improving site conditions for overcup oak.

48. Characteristics of the standing and fallen dead tree material on the two sites were similar. Dead tree material in bottomland hardwood forests is important to wildlife for denning and/or locating food.

49. Numbers of tree cavities of potential use to wildlife and density of cavity trees were similar on both sites (Table 7). These data included cavities which ranged in size from the smallest, which would be of potential use to a small cavity-nesting bird such as a prothonotary warbler, to any larger sized cavity that could provide a sheltered den. The search for cavities was not exhaustive, and many cavities were probably overlooked or hidden by foliage. Therefore, the data in Table 7 are conservative, most likely underestimating the true numbers of cavities.

50. The substantial differences between the two sites in understory and herbaceous layer forest components suggest changes induced by

annual reservoir management. The significantly higher stem densities of water hickory, overcup oak, and buttonbush on the greentree reservoir (Table 8 and Figure 6) indicate that a shift to a wetter forest community is occurring. The significantly lower stem densities for Carolina snailseed, vine starjessamine, trumpet creeper, and saw greenbriar in the greentree reservoir indicate lesser tolerance of these species to the increase in flooding.

51. The differences in many understory importance value ranks between the two sites (Figure 6) appear to be in response to long-term greentree reservoir management (Table 8). For example, swamp privet, water hickory, overcup oak, green ash, green hawthorn, Alabama supplejack, American snowbell, Nuttall oak, and common buttonbush were substantially higher in their relative ranks on the greentree reservoir, suggesting they prospered under greentree management. Possumhaw holly, sugarberry, grapes, common poison ivy, Carolina snailseed, vine starjessamine, trumpet creeper, American elm, saw greenbriar, and common greenbriar were substantially lower in rank on the greentree reservoir, suggesting they declined under greentree management. Southern swamp dogwood is a species that appears to be intolerant of the added moisture of the greentree management regime. It was relatively abundant in the understory of the reference site (83 stems/ha) but was absent in the greentree reservoir.

52. The vast majority of the stems sampled in the herbaceous layer were seedlings or sprouts of woody species with the potential of ascending to the understory or overstory. Stem densities of seedlings and sprouts were significantly lower on the greentree site herbaceous layer. Reduced species diversity on the greentree reservoir is also indicative of more extreme conditions there. Not all species reduced their stem densities on the greentree reservoir, however. Water-tolerant species such as water hickory and Alabama supplejack (Whitlow and Harris 1979) had significantly greater stem densities. Overcup oak, common poison ivy, swamp privet, and common buttonbush had greater stem densities in the herbaceous layer of the greentree reservoir, but the differences were not statistically significant. Significantly lower

stem densities on the greentree reservoir were found for vine starjessamine, sugarberry, Carolina snailseed, American buckwheat vine, trumpet creeper, saw greenbriar, and green hawthorn. Differences were found for other species but they were not statistically significant. The large difference in herbaceous layer species diversity between the reference and the greentree areas makes direct comparison of the lower ranked species less meaningful than it was for the understory species, which had approximately equal species diversity in both areas.

53. The total number of birds was greater but the total number of species was lower on the Delta National Forest study sites than those reported in a south-central Louisiana bottomland hardwood forest by Dickson (1978). Two factors may account for these differences. First, while both study areas were bottomland hardwood forest types, the habitats were not identical. For example, Dickson (1978) reported on a study area consisting of water oak (*Q. nigra*), sweetgum, sugarberry, cherrybark oak (*Q. falcata* var. *pagodaefolia*), cow oak (*Q. michauxii*), giant cane (*Arundinaria gigantea*), palmetto (*Sabal minor*), and ironwood (*Carpinus caroliniana*), with a basal area of 28.2 m^2/ha. This forest composition appears to indicate a much drier site than that used in the present study, according to the cover types/moisture regime classification presented by Huffman and Forsythe (1981). Second, Dickson (1978) sampled approximately eight times per month, while in the present study, sampling was limited to only three or four times per month. Because of the reduced number of samples, some of the transient species passing through the study site during migration seasons were probably missed. However, the consistency found between sites from one count to the next for permanent resident species indicates that these data are reliable.

54. There was great consistency in numbers of species and total population found on the two sites, with the obvious exception of the waterfowl that used the flooded greentree reservoir. During the study period June 1980 to May 1981, the Mississippi Delta experienced rather dry weather conditions. Flooding did not occur on the reference site except for very short periods of time in the deeper sloughs after extremely heavy, but short-lived, rainfalls. It is probable that if

standing water had been present during the winter the reference site may also have attracted waterfowl. In its dry condition, however, no waterfowl were censused there.

55. Common grackles were a notable exception to the consistency noted between the two sites. The extremely large winter populations of grackles on both sites were similar to the large population documented by Dickson (1978). Further, the common grackles appeared to have a decided affinity for the flooded site. Not only were winter populations much higher on the greentree reservoir when it was flooded, but also large numbers of common grackles were drawn to the greentree reservoir whenever it ponded water, such as after heavy rainstorms. Large groups of common grackles were almost always censused in close proximity to the standing water.

56. Despite the presence of water on the greentree site, populations of other bird species tended to be remarkably stable between sites. Monthly variation in numbers of species and mean populations for most species did not appear to be affected by differential flooding. There were exceptions such as the white-throated sparrow which, during flooding, almost disappeared from the greentree reservoir and was censused there only on an occasional hummock of land too high in elevation to be inundated. For the majority of bird species, however, differences between sites were subtle and did not appear to be due to inundation of the greentree reservoir.

57. Oak mast was produced on both sites. Casual observations indicated it was attractive to birds and other wildlife and consumed by them on both sites. The fruit of sugarberry was heavily used by bird species during the fall. One plant species, common mistletoe (*Phoradendron serotinum*), not sampled because of its parasitic growth habit high in the canopy, produced large amounts of fruit that did not appear particularly attractive to birds until the coldest days of winter when it was used heavily.

58. Vines also produced a substantial amount of fruit and have been overlooked generally as a potentially significant source of wildlife food in bottomland hardwood forests. Much of the fruit produced is

readily available high in the canopy where it is easily overlooked by observers on the ground. Common poison ivy, Carolina snailseed, peppervine, and American buckwheat vine all produced heavy crops of fruit during the period of this study. Much of the fruit was retained on these vines well into the winter where it remained available to wildlife. This study documents the relative importance of vine species as components of the bottomland hardwood plant community. This importance should also be emphasized in relation to the value of many of the vine species as sources of wildlife food.

PART V: CONCLUSIONS

59. Continuous greentree reservoir management over 18 years appears to be causing a predictable shift on the study site to a more water-tolerant plant community. Composition of the overstory was similar on both sites, but the understory and herbaceous layer were different on the greentree reservoir. In the understory, survival was greater for the more water-tolerant species, water hickory, overcup oak, and common buttonbush; there was lower survival for Carolina snailseed, vine starjessamine, trumpet creeper, and saw greenbriar. Total stem density in the herbaceous layer of the greentree reservoir was significantly lower and was greater only in the cases of the most water-tolerant species such as water hickory, overcup oak, swamp privet, and common buttonbush.

60. Winter flooding of the greentree reservoir makes it more attractive to common grackles and highly attractive to waterfowl, but less attractive to white-throated sparrows. For other species, however, greentree reservoir management appears to have very little effect on species richness or mean populations.

61. The overstory, topography, and soils were very similar at both sites; however, the hydrology was very different between them. The greentree site was inundated during the dormant season but also ponded water during the year. While it can be concluded that the species shifts observed in the understory and herbaceous layers were caused by greentree reservoir management, neither dormant season flooding, growing season flooding, nor the interaction of both can be singled out as the sole cause.

62. The reported observations indicate that under the current management scheme, a shift in the composition of the forest community is likely to occur. If the expected shift is undesirable, the changes can be reduced by several methods. The drainage system of the Sunflower Waterfowl Project requires an improved design to remove water more quickly from the greentree reservoir and reduce the amount of ponding during the growing season. The greentree reservoir could be flooded

only every second or third winter to permit thorough drying and soil aeration. Finally, the duration of flooding could be further reduced and timed so that no chance existed for overlap into the growing season.

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Table 1

Characteristics of the Greentree and Reference Sites Identified Prior to Field Data Collection

Parameter	Greentree	Reference	Comments
Overstory	Cover type 93	Cover type 93	Identical
Topography	Relatively flat, low-lying land with depressional drainage	Relatively flat, low-lying land with depressional drainage	Virtually identical
Soils	Sharkey series	Sharkey series	Virtually identical
Hydrology	Natural flooding	Artificial impoundment during winter and natural flooding	Dissimilar

Table 2

Summary of Vegetation Analyses for the Overstory with Rank by Importance Value

Species	Density stems/ha	Relative Density	Dominance m^2/ha	Relative Dominance	Frequency	Relative Frequency	Importance Value	Reference Rank	Greentree Rank
				Reference Site					
Sugarberry	145	28.62	4.09	14.68	0.93	13.73	57.03	1	1
Nuttall oak	58	11.35	7.59	27.23	0.67	9.80	48.38	2	2
Green ash	31	6.08	5.73	20.54	0.67	9.80	36.42	3	3
Overcup oak	38	7.57	4.92	17.64	0.63	9.31	34.52	4	4
American elm	61	12.01	0.92	3.30	0.63	9.31	24.62	5	6
Water hickory	16	3.12	1.97	7.08	0.40	5.88	16.08	6	5
Possumhaw holly	32	6.25	0.16	0.56	0.60	8.82	15.63	7	10
Swamp privet	33	6.41	0.25	0.90	0.30	4.41	11.72	8	7
Southern swamp dogwood	28	5.59	0.16	0.56	0.37	5.39	11.54	9	-
Common persimmon	22	4.28	0.28	0.99	0.37	5.39	10.66	10	8
Common poison ivy	11	2.14	0.05	0.17	0.37	5.39	7.70	11	13
American sweetgum	10	1.97	0.53	1.89	0.20	2.94	6.80	12	-
Green hawthorn	11	2.14	0.07	0.26	0.27	3.92	6.32	13	11
Grapes	6	1.15	0.02	0.09	0.17	2.45	3.69	14	15
Willow oak	1	0.16	0.59	2.11	0.03	0.49	2.76	15	17
Common bald cypress	1	0.16	0.49	1.76	0.03	0.49	2.41	16	14
Red maple	3	0.49	0.02	0.06	0.07	0.98	1.53	17	-
Cedar elm	2	0.33	0.01	0.04	0.07	0.98	1.35	18	-
Water elm	1	0.16	0.04	0.13	0.03	0.49	0.78	19	9
Total	510	99.98	27.89	99.99	6.81	99.97	299.94		

(Continued)

Table 2 (Concluded)

Species	Density stems/ha	Relative Density	Dominance m^2/ha	Relative Dominance	Frequency	Relative Frequency	Importance Value	Reference Rank	Greentree Rank
				Greentree Reservoir					
Sugarberry	94	21.20	5.75	25.12	0.93	14.81	61.13	1	1
Nuttall oak	48	10.69	6.16	26.90	0.90	14.29	51.88	2	2
Green ash	48	10.88	4.15	18.15	0.83	13.23	42.26	3	3
Overcup oak	53	11.82	2.30	10.04	0.67	10.58	32.44	4	4
American elm	41	9.19	0.75	3.29	0.60	9.52	22.00	5	6
Water hickory	43	9.57	2.37	10.37	0.60	9.52	29.46	6	5
Possumhaw holly	12	2.63	0.06	0.27	0.20	3.17	6.07	7	10
Swamp privet	53	12.01	0.40	1.74	0.40	6.35	20.10	8	7
Common persimmon	14	3.19	0.13	0.58	0.37	5.82	9.59	10	8
Common poison ivy	4	0.94	0.02	0.08	0.10	1.59	2.61	11	13
Green hawthorn	8	1.69	0.04	0.15	0.23	3.70	5.54	13	11
Grapes	3	0.56	0.01	0.05	0.07	1.06	1.67	14	15
Willow oak	1	0.19	0.01	0.03	0.03	0.53	0.75	15	17
Common bald cypress	1	0.19	0.41	1.81	0.03	0.53	2.53	16	14
Water elm	18	3.94	0.15	0.64	0.10	1.59	6.17	19	9
Honey locust	3	0.75	0.17	0.74	0.13	2.12	3.61	-	12
Common buttonbush	2	0.37	0.01	0.03	0.07	1.06	1.46	-	16
Alabama supplejack	1	0.19	tr*	0.01	0.03	0.53	0.73	-	18
Total	447	100.00	22.89	100.00		100.00	300.00		

* Trace (less than 0.01).

Table 3

Frequency of Occurrence of Trees in Various DBH (cm) Classes (Raw Count from Thirty 0.04-ha Plots)

Common Name	≥6.6 <11.7	≥11.7 <16.8	≥16.8 <21.9	≥21.9 <27.0	≥27.0 <32.1	≥32.1 <37.2	≥37.2 <42.3	≥42.3 <47.4	≥47.4 <52.5	≥52.5 <57.6	≥57.6 <62.7	≥62.7 <67.8	≥67.8 <72.9	≥72.9 <78.0	≥78.0 <83.1	≥83.1 <88.2	≥88.2 <93.3	≥93.3 <98.4	≥98.4 <108.6	≥108.6
Reference Site																				
American elm	40	20	7	2	2	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
American sweetgum	2	2	1	4	--	--	2	1	--	--	--	--	--	--	--	--	--	--	--	--
Cedar elm	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Common bald cypress	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
Common persimmon	20	4	--	1	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Common poison ivy	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Grapes	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Green ash	7	3	1	1	1	4	1	2	4	--	4	1	4	1	2	1	--	--	--	--
Green hawthorn	12	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nuttall oak	30	10	1	1	2	4	1	2	3	--	4	1	2	1	2	2	1	1	--	1
Overcup oak	16	8	3	4	--	2	1	1	--	1	2	2	2	1	2	--	--	--	--	1
Possumhaw holly	38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Red maple	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Southern swamp dogwood	33	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sugarberry	109	30	7	3	3	9	3	3	3	2	1	1	--	--	--	--	--	--	--	--
Swamp privet	33	5	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Water elm	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Water hickory	10	1	--	--	1	1	1	--	--	1	1	1	1	--	--	--	--	--	1	--
Willow oak	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--
Greentree Reservoir																				
Alabama supplejack	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
American elm	24	11	9	2	2	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Common bald cypress	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--
Common buttonbush	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Common persimmon	12	4	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Common poison ivy	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Grapes	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Green ash	26	8	2	3	1	2	3	2	--	4	2	1	2	2	--	--	--	--	--	--
Green hawthorn	9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Honey locust	1	--	1	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nuttall oak	18	4	4	2	5	1	1	4	4	1	3	5	1	2	1	1	--	--	--	--
Overcup oak	34	7	6	4	2	2	3	2	--	1	--	--	1	1	--	--	--	--	--	--
Possumhaw holly	13	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sugarberry	49	8	8	3	7	14	7	8	3	3	1	1	1	--	--	--	--	--	--	--
Swamp privet	59	4	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Water elm	18	1	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Water hickory	38	2	1	--	--	--	--	1	3	1	1	3	1	--	--	--	--	--	--	--
Willow oak	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 4

Mean Diameter Growth (mm/yr) for Unsuppressed Trees

Species	Reference	Greentree
Sugarberry		
1945-1962	3.12	2.69
1963-1980	3.47	2.89
1945-1980	3.29	2.79
Green ash		
1945-1962	7.57	6.36
1963-1980	7.78	4.83
1945-1980	7.67	5.59
Overcup oak		
1945-1962	6.16	4.43
1963-1980	5.06	4.31
1945-1980	5.61	4.37
Nuttall oak		
1945-1962	13.24	11.59
1963-1980	8.38	7.45
1945-1980	10.81	9.52

Table 5

Summary of Data Analysis for Standing Dead Trees

Species	Density stems/ha	Relative Density	Dominance m^2/ha	Relative Dominance	Frequency	Relative Frequency	Importance Value
			Reference Site				
Unidentified	9.06	28.95	0.44	15.12	0.17	23.82	67.89
Overcup oak	6.59	21.06	1.57	54.06	0.13	19.05	94.17
Sugarberry	8.24	26.33	0.41	14.21	0.17	23.82	64.36
Green ash	2.47	7.89	0.25	8.55	0.07	9.53	25.97
Water hickory	1.65	5.27	0.10	3.33	0.03	4.76	13.36
Common bald cypress	0.82	2.62	0.10	3.55	0.03	4.76	10.93
American elm	0.82	2.62	0.02	0.84	0.03	4.76	8.22
Green hawthorn	0.82	2.62	0.01	0.31	0.03	4.76	7.69
Swamp privet	0.82	2.62	tr*	0.03	0.03	4.76	7.41
Nuttall oak	0	0	0	0	0	0	0
Oaks	0	0	0	0	0	0	0
Total	31.29	99.98	2.90	100.00	0.69	100.02	300.00
			Greentree Reservoir				
Unidentified	12.35	34.88	1.32	27.81	0.23	25.92	88.61
Sugarberry	10.71	30.25	1.25	26.24	0.23	25.92	82.41
Water hickory	3.29	9.29	0.68	14.28	0.13	14.81	38.38
Overcup oak	2.47	6.98	0.47	9.87	0.07	7.41	24.26
Green ash	1.65	4.66	0.53	11.07	0.07	7.41	23.14
Nuttall oak	2.47	6.98	0.06	1.21	0.07	7.41	15.60
Oaks	0.82	2.32	0.44	9.34	0.03	3.70	15.36
Swamp privet	1.65	4.66	0.01	0.19	0.07	7.41	12.26
Common bald cypress	0	0	0	0	0	0	0
American elm	0	0	0	0	0	0	0
Green hawthorn	0	0	0	0	0	0	0
Total	35.41	100.02	4.76	100.01	0.90	99.99	300.02

* Trace (less than 0.01).

Table 6

Summary of Data Analysis for Down Logs (Diameter $\geq$ 10 cm)

Species	Density Stems/ha	Total Length, m	Mean Length, m	Mean Diameter, m	Mean Volume m^3/ha
		Reference Site			
Overcup oak	14.17	105.2	6.19	0.26	4.51
Unidentified	23.33	91.0	3.25	0.20	2.38
Water hickory	7.50	63.0	7.00	0.23	2.27
Nuttall oak	3.33	36.0	9.00	0.27	1.73
Sugarberry	22.50	61.5	2.28	0.17	1.21
Common bald cypress	1.67	9.5	4.75	0.41	1.04
Green ash	9.17	35.0	3.18	0.11	0.26
Total	81.67				13.40
		Greentree Reservoir			
Unidentified	75.00	297.2	3.30	0.17	5.52
Green ash	4.17	21.5	4.30	0.33	1.52
Sugarberry	10.83	60.2	4.63	0.17	1.13
Water hickory	6.67	26.2	3.28	0.24	1.02
Common bald cypress	1.67	13.5	6.75	0.33	0.96
Overcup oak	5.00	26.0	4.33	0.17	0.48
Nuttall oak	8.33	40.0	4.00	0.12	0.37
Total	111.67				11.00

Table 7

Comparison of Stem Densities and Relative Stem Densities of Cavity T. ees and Number of Cavities/Hectare Between Reference Site and Greentree Reservoir

	Reference Site			Greentree Reservoir		
Species	Density Stems/ha	Relative Stem Density	Cavities/ha	Density Stems/ha	Relative Stem Density	Cavitie /ha
Sugarberry	9.9	40.0	12.3	10.7	46.3	18.1
Green ash	4.1	16.6	4.1	2.5	10.8	3.3
Overcup oak	3.3	13.4	4.1	0.8	3.5	1.7
Nuttall oak	2.5	10.1	3.3	2.5	10.8	2.5
Unidentified*	1.7	6.9	2.5	1.7	7.4	2.5
Water hickory	0.8	3.2	2.8	1.7	7.4	1.7
Swamp privet	0.8	3.2	0.8	--	--	--
Water elm	0.8	3.2	0.8	0.8	3.5	0.8
Common bald cypress	0.8	3.2	1.7	0.8	3.5	1.7
Honey locust	--	--	--	0.8	3.5	0.8
Oaks	--	--	--	0.8	3.5	1.7
Total	24.7	99.8	32.4	23.1	100.2	34.8

* Includes primarily unidentifiable standing dead trees.

Table 8

Summary of Vegetation Analysis for the Understory (Shrubs/Vines/Saplings) with Rank by Importance Value)

Species	Density Stems/ha	Relative Density	Dominance m^2/ha	Relative Dominance	Frequency	Relative Frequency	Importance Value	Reference Rank	Greentree Rank
				Reference Site					
Possumhaw holly	508	11.34	0.45	17.74	0.57	6.67	35.75	1	5
Sugarberry	450	10.04	0.50	19.65	0.50	5.88	35.57	2	4
Grapes	358	7.99	0.21	8.36	0.60	7.06	23.41	3	9
Common poison ivy	350	7.81	0.22	8.57	0.37	4.31	20.69	4	7
Carolina snailseed	342	7.62	0.03	1.19	0.93	10.98	19.79	5	17
Vine starjessamine	225	5.02	tr*	0.12	0.83	9.80	14.94	6	15
Trumpet creeper	158	3.53	0.17	6.61	0.33	3.92	14.06	7	20
Swamp privet	183	4.09	0.16	6.45	0.20	2.35	12.89	8	2
Water hickory	258	5.76	0.05	1.82	0.40	4.71	12.29	9	1
Pepper-vine	242	5.39	0.02	0.83	0.50	5.88	12.10	10	12
Overcup oak	192	4.28	0.10	4.12	0.30	3.53	11.93	11	3
Green ash	167	3.72	0.07	2.83	0.37	4.31	10.86	12	11
Green hawthorn	117	2.60	0.08	3.14	0.33	3.92	9.66	13	8
Alabama supplejack	200	4.46	0.05	1.95	0.23	2.75	9.16	14	6
American elm	75	1.67	0.14	5.35	0.13	1.57	8.59	15	19
American snowbell	150	3.35	0.02	0.80	0.37	4.31	8.46	16	10
American buckwheat vine	125	2.78	0.00	0.12	0.43	5.10	8.00	17	16
Nuttall oak	75	1.67	0.10	3.81	0.17	1.96	7.44	18	14
Southern swamp dogwood	83	1.86	0.11	4.25	0.10	1.18	7.29	19	--
Saw greenbrier	50	1.12	0.00	0.00	0.20	2.35	3.47	20	24
Common persimmon	33	0.74	0.03	1.07	0.10	1.18	2.99	21	18
Common greenbrier	42	0.93	0.00	0.00	0.17	1.96	2.89	22	23
Common buttonbush	42	0.93	tr	0.19	0.13	1.57	2.69	23	13
Honey locust	8	0.19	0.03	1.02	0.03	0.39	1.60	24	22
Bristly greenbrier	17	0.37	0.00	0.00	0.07	0.78	1.15	25	--
Greenbrier	17	0.37	0.00	0.00	0.03	0.78	1.15	26	--
Wisteria	8	0.19	0.00	0.00	0.03	0.39	0.58	27	--
Bur cucumber	8	0.19	0.00	0.00	0.03	0.39	0.58	28	--
Total	4483	100.01	2.54	99.99	8.45	99.98	299.98		

(Continued)

* Trace (less than 0.01).

Table 8 (Concluded)

Species	Density Stems/ha	Relative Density	Dominance m^2/ha	Relative Dominance	Frequency	Relative Frequency	Importance Value	Reference Rank	Greentree Rank
				Greentree Reservoir					
Water hickory	1203	19.06	0.60	18.90	0.87	9.91	47.87	9	1
Swamp privet	717	11.36	0.60	18.82	0.33	3.76	33.94	8	2
Overcup oak	593	9.40	0.23	7.23	0.57	6.49	23.12	11	3
Sugarberry	437	6.92	0.32	9.89	0.50	5.69	22.50	2	4
Possumhaw holly	354	5.61	0.29	9.18	0.57	6.49	21.28	1	5
Alabama supplejack	527	8.35	0.14	4.48	0.57	6.49	19.32	14	6
Common poison ivy	329	5.22	0.23	7.29	0.33	3.76	16.27	4	7
Green hawthorn	206	3.26	0.15	4.74	0.47	5.35	13.35	13	8
Grapes	255	4.05	0.12	3.89	0.43	4.90	12.84	3	9
American snowbell	247	3.92	0.03	0.87	0.67	7.63	12.43	16	10
Green ash	198	3.13	0.14	4.46	0.40	4.56	12.15	12	11
Pepper-vine	313	4.96	0.04	1.25	0.50	5.69	11.90	10	12
Common buttonbush	247	3.92	0.08	2.56	0.37	4.21	10.69	23	13
Nuttall oak	173	2.74	0.09	2.68	0.40	4.56	9.98	18	14
Vine starjessamine	132	2.09	tr*	0.06	0.50	5.69	7.84	6	15
American buckwheat vine	124	1.96	tr	0.09	0.43	4.90	6.95	17	16
Carolina snailseed	82	1.31	tr	0.09	0.30	3.42	4.82	5	17
Common persimmon	41	0.65	0.06	1.81	0.13	1.48	3.94	21	18
American elm	33	0.52	0.04	1.12	0.10	1.14	2.78	15	19
Trumpet creeper	25	0.39	0.01	0.32	0.07	0.80	1.51	7	20
Common bald cypress	17	0.26	0.01	0.26	0.07	0.80	1.32	-	21
Honey locust	25	0.39	tr	0.01	0.07	0.80	1.20	24	22
Common greenbrier	16	0.26	0	0	0.07	0.80	1.06	22	23
Saw greenbrier	8	0.13	0	0	0.03	0.34	0.47	20	24
Indigobush amorpha	8	0.13	0	0	0.03	0.34	0.47	-	25
Total	6310	99.99	3.18	100.00	8.78	100.00	300.00		

* Trace (less than 0.01).

Table 9

Summary of Vegetation Analysis of Herbaceous Layer

Species	Density Stems/ha	Relative Density	Frequency	Relative Frequency	Importance Value	Reference Rank	Greentree Rank
			Reference Site				
Vine starjessamine	18,192	26.44	1.00	6.46	32.90	1	2
Common poison ivy	10,933	15.89	0.90	5.82	21.71	2	1
Sugarberry	6,575	9.56	0.97	6.27	15.83	3	6
Carolina snailseed	5,567	8.09	0.93	6.01	14.10	4	9
American buckwheat vine	4,733	6.88	0.90	5.82	12.70	5	4
Pepper-vine	3,792	5.51	0.97	6.27	11.78	6	3
Trumpet creeper	3,900	5.67	0.77	4.98	10.65	7	15
Saw greenbrier	2,133	3.10	0.90	5.82	8.92	8	16
Swamp privet	1,617	2.35	0.67	4.33	6.68	9	5
American snowbell	592	0.86	0.73	4.72	5.58	10	10
Southern dewberry	1,992	2.89	0.40	2.59	5.48	11	--
Grapes	583	0.85	0.60	3.88	4.73	12	12
Smallspike false nettle	892	1.30	0.47	3.04	4.34	13	25
Knot root bristlegrass	442	0.64	0.50	3.23	3.87	14	--
Overcup oak	650	0.94	0.43	2.78	3.72	15	8
Green ash	633	0.92	0.33	2.13	3.05	16	18
Water hickory	283	0.41	0.40	2.59	3.00	17	7
Green hawthorn	242	0.35	0.40	2.59	2.94	18	21
Possumhaw holly	192	0.28	0.40	2.59	2.87	19	17
Common buttonbush	625	0.91	0.30	1.94	2.85	20	13
Common persimmon	167	0.24	0.30	1.94	2.18	21	19
Ammania	1,292	1.88	0.03	0.19	2.07	22	--
American elm	125	0.18	0.27	1.75	1.93	23	--
Nuttall oak	792	1.15	0.10	0.65	1.80	24	14
Alabama supplejack	175	0.25	0.23	1.49	1.74	25	11
Common greenbrier	75	0.11	0.23	1.49	1.60	26	20
Wisteria	200	0.29	0.20	1.29	1.58	27	26
Greenbriers	125	0.18	0.13	0.84	1.02	28	22
Unknown 1	550	0.80	0.03	0.19	0.99	29	--
Willow oak	58	0.08	0.10	0.65	0.73	30	--
Common bald cypress	58	0.08	0.10	0.65	0.73	31	--
Turnsole	33	0.05	0.10	0.65	0.70	32	--
Slender copperleaf	25	0.06	0.07	0.45	0.51	33	--
Butterweed	17	0.02	0.07	0.45	0.47	34	--
Creeping spot flower	133	0.19	0.03	0.19	0.38	35	--
Water purslane	83	0.12	0.03	0.19	0.31	36	--
Common pokeberry	83	0.12	0.03	0.19	0.31	37	--
Buttonweed	42	0.06	0.03	0.19	0.25	38	--
Climbing hempweed	33	0.05	0.03	0.19	0.24	39	--
Smooth buttonweed	33	0.05	0.03	0.19	0.24	40	--
Mistflower	25	0.04	0.03	0.19	0.23	41	--
Indigobush amorpha	17	0.02	0.03	0.19	0.21	42	23
Water hemp	17	0.02	0.03	0.19	0.21	43	--
Common cocklebur	17	0.02	0.03	0.19	0.21	44	--
Sedge	8	0.01	0.03	0.19	0.20	45	--

(Continued)

Table 9 (Concluded)

Species	Density Stems/ha	Relative Density	Frequency	Relative Frequency	Importance Value	Reference Rank	Greentree Rank
			Reference Site (Continued)				
Dayflower	8	0.01	0.03	0.19	0.20	46	--
Common morning glory	8	0.01	0.03	0.19	0.20	47	--
Oxalis	8	0.01	0.03	0.19	0.20	48	--
Smartweed	8	0.01	0.03	0.19	0.20	49	--
Prickly sida	8	0.01	0.03	0.19	0.20	50	--
Bristly greenbrier	8	0.01	0.03	0.19	0.20	51	--
Violet	8	0.01	0.03	0.19	0.20	52	--
Total	68,807	99.98	15.47	99.96	199.94		
			Greentree Reservoir				
Common poison ivy	7650	25.03	0.73	6.59	31.62	2	1
Vine starjessamine	6325	20.69	0.93	8.38	29.07	1	2
Pepper-vine	3283	10.74	0.90	8.08	18.82	6	3
American buckwheat vine	3242	10.61	0.87	7.78	18.39	5	4
Swamp privet	1742	5.70	0.50	4.49	10.19	9	5
Sugarberry	983	3.22	0.77	6.89	10.11	3	6
Water hickory	658	2.15	0.77	6.89	9.04	17	7
Overcup oak	817	2.67	0.70	6.29	8.96	15	8
Carolina snailseed	1325	4.33	0.50	4.49	8.82	4	9
American snowbell	617	2.02	0.70	6.29	8.31	10	10
Alabama supplejack	758	2.48	0.50	4.49	6.97	25	11
Grapes	375	1.23	0.63	5.69	6.92	12	12
Common buttonbush	900	2.94	0.43	3.89	6.83	20	13
Nuttall oak	550	1.80	0.47	4.19	5.99	24	14
Trumpet creeper	367	1.20	0.30	2.69	3.89	7	15
Saw greenbrier	183	0.60	0.27	2.40	3.00	8	16
Possumhaw holly	133	0.44	0.27	2.40	2.84	19	17
Green ash	117	0.38	0.17	1.50	1.88	16	18
Common persimmon	108	0.35	0.17	1.50	1.85	21	19
Common greenbrier	217	0.71	0.10	0.90	1.61	26	20
Green hawthorn	33	0.11	0.13	1.20	1.31	18	21
Greenbriers	33	0.11	0.10	0.90	1.01	28	22
Indigobush amorpha	67	0.22	0.07	0.60	0.82	42	23
Honey locust	25	0.08	0.07	0.60	0.68	--	24
Smallspike false nettle	33	0.11	0.03	0.30	0.41	13	25
Wisteria	17	0.05	0.03	0.30	0.35	27	26
Unknown 2	8	0.03	0.03	0.30	0.33	--	27
Total	30,566	100.00	11.14	100.02	200.02		

Table 10

Mean Values for Physical and Chemical Soil Characteristics on the Reference Site and Greentree Reservoir

Parameter	Reference Site	Greentree Reservoir
Percent sand	9.30	5.95
Percent silt	33.75	33.95
Percent clay	56.95	60.10
pH	5.25	5.11
TKN,* mg/kg	1822	1803
TC,** mg/kg	17019	18774
P, mg/kg	12.9	13.6
Ca, meq†/100 g	25.1	26.5
Mg, meq/100 g	8.7	9.6
K, meq/100 g	1.0	1.0

* Total Kjeldahl nitrogen.
** Total carbon.
† Milliequivalent.

Table 11

Mean Monthly Bird Population Estimates per km^2 Determined from Transect Counts from the Reference Site ($\bar{R}$) and the Greentree Reservoir ($\bar{G}$)*

Common name (Scientific Name)	1980 Jun $\bar{R}$	Jun $\bar{G}$	Jul $\bar{R}$	Jul $\bar{G}$	Aug $\bar{R}$	Aug $\bar{G}$	Sep $\bar{R}$	Sep $\bar{G}$	Oct $\bar{R}$	Oct $\bar{G}$	Nov $\bar{R}$	Nov $\bar{G}$	Dec $\bar{R}$	Dec $\bar{G}$	1981 Jan $\bar{R}$	Jan $\bar{G}$	Feb $\bar{R}$	Feb $\bar{G}$	Mar $\bar{R}$	Mar $\bar{G}$	Apr $\bar{R}$	Apr $\bar{G}$	May $\bar{R}$	May $\bar{G}$	Residency Status**
Mallard (*Anas platyrhynchos*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	46.7	--	33.3	--	--	--	--	--	--	WR
Wood Duck (*Aix sponsa*)	--	--	--	--	--	-	--	--	--	--	--	247.5	--	--	--	675.0	--	308.3	--	--	--	--	--	--	WR
Red-shouldered hawk (*Buteo lineatus*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.7	3.3	--	6.7	SR
Red-tailed hawk (*Buteo jamaicensis*)	--	--	--	--	--	--	--	--	8.3	--	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	WR
Mourning dove (*Zenaida macroura*)	0.8	1.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.3	--	--	--	10.0	--	R
Yellow-billed cuckoo (*Coccyzus americanus*)	65.0	66.8	30.8	50.0	33.3	36.7	23.0	23.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14.3	24.3	SR
Barred owl (*Strix varia*)	--	--	--	--	--	--	--	0.8	--	--	--	0.8	--	--	1.0	--	--	--	--	--	--	1.0	--	1.7	R
Ruby-throated hummingbird (*Archilochus colubris*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	33.3	SR
Common flicker (*Colaptes auratus*)	--	--	--	--	--	--	50.0	22.5	26.7	60.0	40.0	58.0	26.7	60.7	70.0	29.0	66.3	68.8	6.8	13.3	--	8.3	--	--	R
Pileated woodpecker (*Dryocopus pileatus*)	11.3	18.8	17.5	9.0	3.3	1.7	2.5	3.8	6.7	20.0	7.5	5.0	14.3	10.0	3.3	--	--	7.0	10.0	10.0	43.3	41.7	20.0	33.3	R
Red-bellied woodpecker (*Centurus carolinus*)	80.0	107.8	47.5	55.0	76.7	80.0	56.8	65.0	108.3	80.0	40.0	45.0	33.3	43.3	6.7	126.7	35.0	55.0	100.0	85.7	51.7	43.3	13.3	43.3	R
Red-headed woodpecker (*Melanerpes erythrocephalus*)	--	--	--	--	--	--	40.0	43.0	83.3	63.3	75.0	71.3	56.7	66.7	76.7	40.0	112.0	98.3	--	--	--	--	6.7	10.0	R
Yellow-bellied sapsucker (*Sphyrapicus varius*)	--	--	--	--	--	--	--	--	16.7	--	--	--	21.0	--	--	--	--	--	--	--	--	--	--	--	WR
Hairy woodpecker (*Picoides villosus*)	11.3	20.0	35.0	12.5	--	--	16.3	35.0	26.7	36.7	19.5	16.3	16.7	10.0	21.7	6.7	22.5	23.8	51.7	36.7	8.3	41.7	8.3	46.7	R
Downy woodpecker (*Picoides pubescens*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13.3	8.3	--	--	--	--	R
Great crested flycatcher (*Myiarchus crinitus*)	37.5	35.8	6.3	2.5	--	24.3	--	37.5	--	--	--	--	--	--	--	--	--	--	--	--	3.3	50.0	10.0	23.3	SR
Acadian flycatcher (*Empidonax virescens*)	50.0	32.5	33.8	17.0	33.3	24.3	2.5	37.5	--	--	--	--	--	--	--	--	--	--	--	--	--	8.3	17.7	10.0	SR
Blue Jay (*Cyanocitta cristata*)	15.8	20.0	13.3	2.3	10.0	25.0	26.3	50.8	30.7	10.0	6.3	--	--	--	81.7	53.3	8.8	26.8	27.8	--	--	20.0	26.0	11.7	R
Carolina chickadee (*Parus carolinensis*)	68.8	63.8	6.3	7.5	65.7	76.7	97.5	75.0	125.0	66.7	31.3	31.3	53.3	26.7	54.3	33.3	50.0	61.8	101.7	126.7	46.7	70.0	66.7	36.7	R
Tufted titmouse (*Parus bicolor*)	70.0	71.3	20.0	95.0	43.3	33.3	43.8	37.5	96.7	80.0	43.3	20.0	49.3	16.7	83.3	56.7	83.8	70.0	76.7	113.3	50.0	83.3	36.7	43.3	R
Winter wren (*Troglodytes troglodytes*)	--	--	--	--	--	--	--	--	--	33.3	67.8	--	16.7	--	16.7	33.3	25.0	12.5	--	--	--	--	--	--	WR
Carolina wren (*Thryothorus ludovicianus*)	--	--	5.0	5.0	6.7	10.0	90.0	12.5	45.0	50.0	40.0	27.5	13.3	30.0	10.0	23.3	20.0	--	--	26.7	37.7	25.0	61.0	6.7	R
Gray catbird (*Dumetella carolinensis*)	--	--	--	--	--	--	8.3	2.5	--	--	25.0	--	--	--	--	--	--	--	--	--	--	16.7	--	--	SR
Brown thrasher (*Toxostoma rufum*)	--	--	--	--	--	--	12.5	--	22.3	--	32.5	--	16.7	--	--	16.7	25.0	--	--	--	--	--	--	--	R
American robin (*Turdus migratorius*)	--	--	--	--	--	--	--	--	25.0	103.3	162.5	43.8	170.0	16.7	226.7	153.3	102.5	--	--	10.0	--	--	--	--	WR

(Continued)

* The majority of the bird detections during the breeding season (March through July for permanent and summer residents) were of singing males, therefore these population figures more accurately represent territorial males.
** WR = winter resident; SR = summer resident; R = permanent resident; T = transient.

Table 11 (Concluded)

Common name (Scientific Name)	1980 Jun $\bar{X}$	Jun $\bar{G}$	Jul $\bar{X}$	Jul $\bar{G}$	Aug $\bar{X}$	Aug $\bar{G}$	Sep $\bar{X}$	Sep $\bar{G}$	Oct $\bar{X}$	Oct $\bar{G}$	Nov $\bar{X}$	Nov $\bar{G}$	Dec $\bar{X}$	Dec $\bar{G}$	1981 Jan $\bar{X}$	Jan $\bar{G}$	Feb $\bar{X}$	Feb $\bar{G}$	Mar $\bar{X}$	Mar $\bar{G}$	Apr $\bar{X}$	Apr $\bar{G}$	May $\bar{X}$	May $\bar{G}$	Residency Status
Wood thrush (*Hylocichla mustelina*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17.3	--	16.7	--	17.3	3.3	--	SR
Hermit thrush (*Catharus guttatus*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12.5	22.0	--	--	8.3	--	--	WR
Unknown thrush	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	27.7	16.7	--	--	T
Blue-gray gnatcatcher (*Polioptila caerulea*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	58.3	33.3	66.7	22.3	50.0	--	SR
Golden-crowned kinglet (*Regulus satrapa*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.7	--	--	--	--	--	--	--	--	--	WR
Ruby-crowned kinglet (*Regulus calendula*)	--	--	--	--	--	--	--	--	--	--	--	37.5	122.3	--	50.0	--	25.0	--	--	--	--	--	--	--	WR
White-eyed vireo (*Vireo griseus*)	[illegible]	18.8	6.3	12.5	--	8.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	36.7	10.0	--	--	SR
Red-eyed vireo (*Vireo olivaceus*)	15.0	20.0	27.5	12.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.0	6.7	20.0	13.3	SR
Black-and-white warbler (*Mniotilta varia*)	--	--	--	--	--	--	--	--	16.6	--	12.5	--	--	--	--	--	--	--	--	--	--	--	--	--	T
Prothonotary warbler (*Protonotaria citrea*)	62.5	58.8	2.5	1.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	11.0	41.7	25.0	26.7	60.0	SR
Parula warbler (*Parula americana*)	27.0	19.5	8.3	6.3	--	--	2.5	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	SR
Yellow-rumped warbler (*Dendroica coronata*)	--	--	--	--	--	--	--	12.5	111.0	52.7	75.0	50.0	50.0	166.7	413.3	133.3	170.8	162.5	--	--	--	--	--	--	WR
Common yellowthroat (*Geothlypis trichas*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.7	--	--	16.7	SR
Red-winged blackbird (*Agelaius phoeniceus*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0	--	--	--	--	--	--	R
Orchard oriole (*Icterus spurius*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	25.0	--	--	--	--	6.7	SR
Common grackle (*Quiscalus quiscula*)	22.5	16.8	2.5	--	13.3	16.7	30.0	31.3	60.0	66.7	--	18.8	204.3	283.3	206.7	631.7	722.5	2091.3	86.7	191.7	43.3	146.7	16.7	176.7	R
Brown-headed cowbird (*Molothrus ater*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.3	--	--	--	8.3	--	R
Summer tanager (*Piranga rubra*)	6.3	--	12.5	6.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.7	10.0	--	SR
Cardinal (*Cardinalis cardinalis*)	158.8	141.3	72.5	105.0	76.7	73.3	127.5	62.5	105.7	62.3	33.8	32.5	23.3	30.0	91.7	46.7	82.5	23.3	150.0	126.7	93.3	100.0	98.3	83.3	R
Rufous-sided towhee (*Pipilo erythrophthalmus*)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--	R
Indigo bunting (*Passerina cyanea*)	45.0	65.0	57.5	30.0	56.7	44.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	85.0	46.7	45.0	56.7	SR
Dark-eyed junco (*Junco hyemalis*)	--	--	--	--	--	--	--	--	--	--	--	37.5	33.3	--	--	--	--	--	--	--	--	--	--	--	WR
White-throated sparrow (*Zonotrichia albicollis*)	--	--	--	--	--	--	--	--	--	--	--	25.0	66.7	--	91.7	16.7	112.5	12.5	26.7	33.3	16.7	13.3	--	--	WR
Song sparrow (*Melospiza melodia*)	--	--	--	--	--	--	--	--	--	--	--	--	16.7	--	--	--	--	--	--	--	--	--	--	--	WR
Unknown (*Audial*)	--	18.8	--	--	6.7	--	15.8	12.5	--	16.7	42.5	8.3	13.3	33.3	3.3	--	6.3	23.8	6.7	17.7	45.0	50.0	19.3	16.7	T
Unknown 1 (*Audial*)	--	--	--	--	--	--	13.3	--	11.0	--	--	5.0	16.7	--	13.3	20.0	5.0	--	16.7	--	11.0	--	--	--	T
Unknown 2 (*Audial*)	--	--	--	--	--	--	11.3	--	23.3	--	--	18.8	6.7	--	3.3	10.0	5.0	6.3	6.7	--	--	--	--	--	T
Unknown (*Visual*)	--	--	-	--	--	--	--	--	--	25.0	12.5	--	--	--	--	--	12.5	46.3	--	--	33.3	13.3	11.0	--	T
Total	775.1	797.1	405.1	429.7	425.7	454.6	669.9	567.7	949.0	826.7	772.0	799.9	1041.3	794.1	1542.1	2152.4	1693.0	3261.4	806.8	861.1	784.8	905.6	599.3	761.1	

APPENDIX A: RANDOM NUMBERS FOR VEGETATION SAMPLING ON THE STUDY AREA

The tabulation below presents the random numbers drawn to establish a randomized block experimental design for vegetation sampling on the study area.

	Greentree Reservoir					Reference Site				
Plot Transect	T6 (199)	T7 (437)	T3 (979)	T4 (1163)	T5 (1397)	T6 (94)	T7 (368)	T3 (550)	T4 (855)	T5 (1373)
Q_1	160	143	83	292	107	87	171	87	143	133
Q_2	270	215	173	368	200	214	234	163	206	246
Q_3	393	292	374	438	296	246	391	319	242	489
Q_4	501	359	487	528	479	343	432	494	279	514
Q_5	635	408	677	630	643	393	562	623	472	609
Q_6	715	654	795	737	718	479	732	730	636	698

The baseline of the coordinate grid is the line along the north edge of the top of the south levee bounding Reservoir No. 3. The numbers represent distance in meters. The transect positions (T) are measured in an easterly direction from the zero point, or origin: the midpoint between two steel gate posts at the west end of the south levee. Quadrat locations (Q) in the greentree reservoir are measured from zero at the baseline along a magnetic north (360°) azimuth. Quadrat locations on the reference site are measured from zero at the baseline along a magnetic south (180°) azimuth. At the center of each plot location, a 1.3- by 40-cm section of steel reinforcing rod was driven into the ground flush with the surface to permanently mark the position and facilitate relocation by use of a metal detector.

APPENDIX B: DEFINITIONS OF TERMS

Basal area: The area of a circle calculated from the diameter or circumference of a tree at breast height.

Cavity tree: Any tree class plant specimen (alive or dead) having at least one visible cavity of potential use to a resident or nesting wildlife species (e.g., as a nesting cavity for a Carolina wren, fox squirrel, racoon, or wood duck).

Density: Number of individuals (or stems) per unit area.

Diameter breast height (dbh): Diameter of a tree, shrub, vine, or sapling measured at breast height, or 1.5 m from the ground.

Dominance: Total of basal area for a species per unit area.

Down dead: Fallen dead logs or branches in the tree diameter class ($\geq$6.6 cm). In this study, length (to the nearest m) and diameter at the middle (to the nearest cm) were measured, and the species was noted if it could be identified.

Frequency: Number of quadrats in which a species occurs/total number of quadrats sampled.

Importance value: A synthetic approximation of a species' significance in the plant community calculated by summing relative density, relative dominance, and relative frequency. Since the sum of all importance values for a set of plant community data equals 300, this measure is also called "Importance Value 300," or "I.V. 300." (In some cases, importance value is based on the sum of only two of the relativized measures, such as relative density and relative frequency, and is then referred to as "Importance Value 200," or "I.V. 200.")

Litter layer: The blanket of organic material composed of matter recognizable as plant parts which commonly covers the soil on the forest floor.

Overstory (or canopy): That layer of vegetation formed by the crowns of mature and nearly mature, dominant forest trees such as oaks (*Quercus* spp.), bitter pecan (*Carya aquatica*), sugarberry (*Celtis laevigata*), and green ash (*Fraxinus pennsylvanica* var. *subintegerrima*).

Percent cover: That percentage of area within a measured quadrat that is either covered by litter or would be covered should the living leaves and stems of seedlings and herbaceous plants fall vertically to the ground. The cover classes used in this study were: 0-1, 1-5, 5-10, 10-25, 25-50, 50-75, 75-95, and 95-100 percent.

Quadrat: A sampling plot of a specified shape and dimension.

Relative density: (Density for a species/total density for all species) × 100.

Relative dominance: (Dominance for a species/total dominance for all species) × 100.

Relative frequency: (Frequency value for a species/total of frequency values for all species) × 100.

Saplings: Younger individuals of woody plant species that can attain the stature of canopy trees when mature. For this study, individuals of all woody species ≥1.0 m in length and <6.6 cm dbh were classified as shrub/vine/sapling. The dbh ≥1.0 cm (to the nearest 0.1 cm) and height (to the nearest 0.5 m) were recorded for each sapling.

Seedling: Any individual of a woody species <1 m in height.

Shrubs: Individuals of woody plant species common to the understory which normally do not reach canopy tree stature when mature. For this study, all individuals of woody species ≥1.0 m in length and <6.6-cm dbh were classified as shrub/vine/sapling. Shrubs often have more than one primary stem (i.e., a stem rising from ground level at the base of the plant). For each primary stem, dbh ≥1.0 cm (to the nearest 0.1 cm) and height (to the nearest 0.5 m) were recorded.

Standing dead: A class of vegetation which includes all dead trees that are upright or standing. For this study, the dbh of these trees was measured to the nearest centimeter. If the specimen was a stump, its top diameter and height were measured to the nearest centimeter. If they could be identified, the species of standing dead trees were recorded; if not, they were labelled as "unknown."

Unsuppressed: Refers to a tree that is uncrowded by neighboring trees (i.e., has no nearby stumps or other evidences of tree removal) which would compete for light, that has a broad crown relative to its height (as compared with other trees of the same species in the stand), and that has virtually no dead branches or signs of disease.

Vines: For this study a vine was defined as any individual of the following species ≥1.0 m in length and <6.6-m dbh: *Ampelopsis arborea, Berchemia scandens, Brunnichia cirrhosa, Cocculus carolinus, Rhus radicans, Trachelospermum difforme, Smilax* spp., and *Vitis* spp. The dbh ≥1.0 cm (to the nearest 0.1 cm) was recorded for vines.

APPENDIX C: SCIENTIFIC AND COMMON NAMES OF PLANTS

Plants Alphabetized by Scientific Name

Scientific Name*	Common Name
Acalypha gracilens	Slender copperleaf
Acer rubrum	Red maple
Amaranthus tamariscinus	Water hemp
Ammannia coccinea	Ammannia
Amorpha fruticosa	Indigobush amorpha
Ampelopsis arborea	Pepper-vine
Berchemia scandens	Alabama supplejack
Boehmeria cylindrica	Smallspike false nettle
Brunnichia cirrhosa	American buckwheat vine
Campsis radicans	Trumpet creeper
Carex sp.	Sedge
Carya aquatica	Water hickory
Celtis laevigata	Sugarberry
Cephalanthus occidentalis	Common buttonbush
Cocculus carolin[illegible]	Carolina snailseed
Commelina diffusa	Dayflower
Cornus foemina	Southern swamp dogwood
Crataegus viridus	Green hawthorn
Diodia virginiana	Buttonweed
Diospyros virginiana	Common persimmon
Eupatorium coelestinum	Mistflower
Forestiera acuminata	Swamp privet
Fraxinus pennsylvanica var. *subintegerrima*	Green ash
Gleditsia triacanthos	Honey locust
Heliotropium indicum	Turnsole
Ilex decidua	Possumhaw holly
Ipomea purpurea	Common morning glory
Liquidambar styraciflua	American sweetgum
Ludwigia glandulosa	Water purslane
Mikania scandens	Climbing hempweed
Oxalis spp.	Oxalis
Phytolacca americana	Common pokeberry
Planera aquatica	Water elm
Polygonum spp.	Smartweed
Quercus lyrata	Overcup oak
Quercus nuttallii	Nuttall oak
Quercus phellos	Willow oak
Quercus spp.	Oaks
Rhus radicans	Common poison ivy

* Scientific nomenclature follows Radford et al. (1968). Where possible common names were taken from Scott and Wasser (1980); otherwise, Radford et al. (1968) or Fernald (1970) were the sources.

Plants Alphabetized by Scientific Name (Continued)

Scientific Name	Common Name
Rubus trivialis	Southern dewberry
Senecio glabellus	Butterweed
Setaria geniculata	Knotroot bristlegrass
Sicyos angulatus	Bur cucumber
Sida spinosa	Prickly sida
Smilax bona-nox	Saw greenbrier
Smilax hispida	Bristly greenbrier
Smilax rotundifolia	Common greenbrier
Smilax spp.	Greenbrier
Spermacoce glabra	Smooth buttonweed
Spilanthes americana	Creeping spot flower
Styrax americana	American snowbell
Taxodium distichum	Common bald cypress
Trachelospermum difforme	Vine starjessamine
Ulmus americana	American elm
Ulmus crassifolia	Cedar elm
Viola sp.	Violet
Vitis, spp.	Grapes
Wisteria macrostachya	Wisteria
Xanthium sturmarium	Common cocklebur

Plants Alphabetized by Common Name

Common Name	Scientific Name
Alabama supplejack	*Berchemia scandens*
American buckwheat vine	*Brunnichia cirrhosa*
American elm	*Ulmus americana*
American snowbell	*Styrax americana*
American sweetgum	*Liquidambar styraciflua*
Ammania	*Ammania coccinea*
Bristly greenbrier	*Smilax hispida*
Bur cucumber	*Sicyos angulatus*
Butterweed	*Senecio glabellus*
Buttonweed	*Diodia virginiana*
Carolina snailseed	*Cocculus carolinus*
Cedar elm	*Ulmus crassifolia*
Climbing hempweed	*Mikania scandens*
Common bald cypress	*Taxodium distichum*
Common buttonbush	*Cephalanthus occidentalis*
Common cocklebur	*Xanthium sturmarium*
Common greenbrier	*Smilax rotundifolia*
Common morning glory	*Ipomea purpurea*
Common persimmon	*Diospyros virginiana*
Common poison ivy	*Rhus radicans*

(Continued)

Plants Alphabetized by Common Name (Concluded)

Common Name	Scientific Name
Common pokeberry	*Phytolacca americana*
Creeping spot flower	*Spilanthes americana*
Dayflower	*Commelina diffusa*
Grapes	*Vitis* spp.
Green ash	*Fraxinus pennsylvanica* var. *subintegerrima*
Green hawthorn	*Crataegus viridus*
Greenbrier	*Smilax* spp.
Honey locust	*Gleditsia triacanthos*
Indigobush amorpha	*Amorpha fruticosa*
Knotroot bristlegrass	*Setaria geniculata*
Mist flower	*Eupatorium coelestinum*
Nuttall oak	*Quercus nuttallii*
Oaks	*Quercus* spp.
Overcup oak	*Quercus lyrata*
Oxalis	*Oxalis* spp.
Pepper-vine	*Ampelopsis arborea*
Possumhaw holly	*Ilex decidua*
Prickly sida	*Sida spinosa*
Red maple	*Acer rubrum*
Saw greenbrier	*Smilax bona-nox*
Sedge	*Carex* spp.
Slender copperleaf	*Acalypha gracilens*
Smallspike false nettle	*Boehmeria cylindrica*
Smartweed	*Polygonum* spp.
Smooth buttonweed	*Spermacoce glabra*
Southern dewberry	*Rubus trivialis*
Southern swamp dogwood	*Cornus foemina*
Sugarberry	*Celtis laevigata*
Swamp privet	*Forestiera acuminata*
Trumpet creeper	*Campsis radicans*
Turnsole	*Heliotropium indicum*
Vine starjessamine	*Trachelospermum difforme*
Violet	*Viola* sp.
Water elm	*Planera aquatica*
Water hemp	*Amaranthus tamariscinus*
Water hickory	*Carya aquatica*
Water purslane	*Ludwigia glandulosa*
Willow oak	*Quercus phellos*
Wisteria	*Wisteria macrostachya*

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Newling, Charles J.
  Ecological investigation of a greentree reservoir in the Delta National Forest, Mississippi / by Charles J. Newling (Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. ; available from NTIS, 1982.
  65 p. in various pagings : ill. ; 27 cm. -- (Miscellaneous paper ; EL-81-5)
  Cover title.
  "September 1981."
  Final report.
  "Prepared for Assistant Secretary of the Army (R&D), Department of the Army."
  Bibliography: p. 41-44.

  1. Delta National Forest (Miss.) 2. Ecological succession. 3. Floods. 4. Forests and forestry. 5. Reservoirs. I. United States. Assistant Secretary of the Army (R&D). II. U.S. Army Engineer Waterways

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